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Office of Community Planning and Development

Applying the Cost-Effective Energy Standards in Rehabilitation Projects

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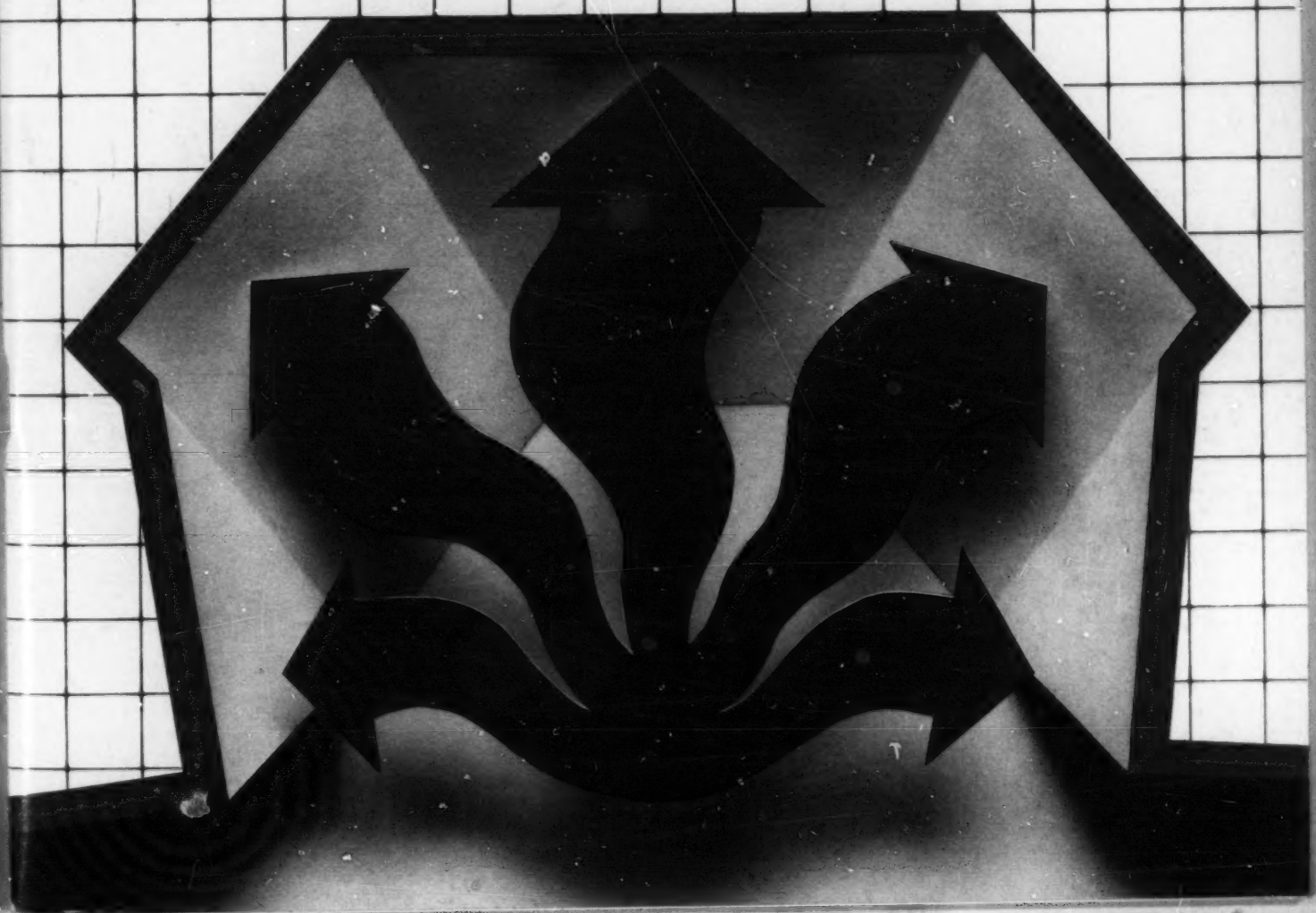

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Applying the Cost-Effective Energy Standards in Rehabilitation Projects

Prepared for:

U.S. Department of Housing and Urban Development
Office of Community Planning and Development
Office of Urban Rehabilitation

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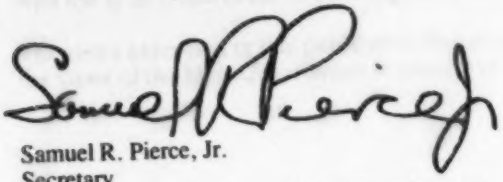
Foreword

Rising energy costs have been a major factor in the decade-long escalation of home maintenance costs. The impact of high heating bills is most severely felt by people with low and moderate incomes who have little flexibility in their budgets to handle these continuing increases.

As a provider of Federal funds for housing rehabilitation, the Department of Housing and Urban Development (HUD) wants to assure that reasonable and cost-effective energy measures are undertaken in addition to basic repairs. In this way, the Department and the localities delivering rehabilitation services can assist in improving the housing stock and at the same time help community residents to save on their energy bills. HUD has established Cost Effective Energy Conservation Standards (CEECS) to help meet that goal. The Standards require that appropriate energy conservation measures be included in HUD-funded property repair programs.

This publication will assist local Community Development managers and their staffs in applying these Standards to properties they rehabilitate. It describes the Standards, tells how to use them in both single and multifamily properties, offers information on the energy conservation measures required, and explains different conditions under which the most common of these are used.

This publication brings valuable technical information to local officials on when and how to apply the HUD standards. Our aim is to be partners with local communities in helping them to deliver decent, affordable housing that can be maintained at maximum energy conservation and cost-efficiency.

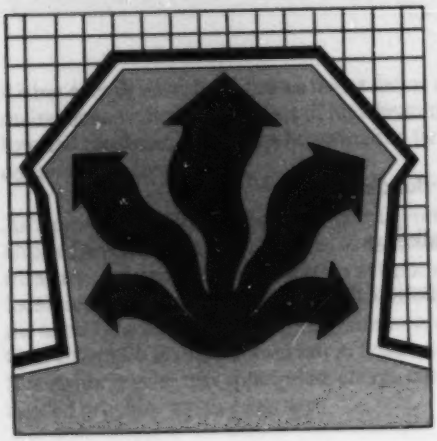


Samuel R. Pierce, Jr.
Secretary
Department of Housing and Urban Development

Contents

Chapter 1	Introduction	4
Chapter 2	The Cost-Effective Energy Conservation Standards	6
Chapter 3	Carrying Out Energy-Saving Requirements for Single-Family Buildings	15
Chapter 4	Carrying Out Energy-Saving Requirements for Multifamily Buildings	22
Chapter 5	Implementating the Energy Standards Through HUD Rehabilitation Programs	29
Appendix A	Loan Program Table	32
Appendix B	Heating Degree Days Table	35
Appendix C	Cooling Hours Table	40
Appendix D	Estimating First-Year Savings for Multifamily Buildings	41
Appendix E	Energy Audit Questionnaire for Multifamily Buildings	48
Appendix F	List of HUD Area Offices	55
Glossary		57

CHAPTER 1



Introduction

The energy situation in the United States has changed radically in the last three decades. Fuel shortages and skyrocketing costs have made inefficient energy consumption synonymous with economic folly. Installing energy conservation measures in homes and apartments not only supports national energy conservation goals but is also a wise investment.

During the early 1970s a number of government-sponsored studies showed that of the 70 million housing units then in existence in the U.S., well over half were in need of such energy conservation improvements as insulation, caulking, weatherstripping, and storm doors and windows. Other studies calculated that the addition or installation of energy conservation measures could produce savings estimated to range from 10 to 50% for retrofitted, or weatherized, buildings and from 50 to 80% for new buildings.

THE COST-EFFECTIVE ENERGY CONSERVATION STANDARDS

As a result of these studies, Congress mandated the development of the HUD Cost-Effective Energy Conservation Standards. The Energy Standards, authorized by the Housing and Community Development Amendments of 1978 (P.L. 95-557), require a wide range of retrofitting activities to be included in a number of HUD rehabilitation programs. Those programs of greatest interest to readers of this publication are the Section 312 Rehabilitation Loan program and the Community Development Block Grant program.

During Fiscal Year 1982, the Section 312 Rehabilitation Loan Program was funded through loan repayments. It was also redirected and targeted to multifamily and urban homesteading properties.

The Community Development Block Grant (CDBG) program can provide grants, loans, and other types of funding to help local governments accomplish community development objectives. The Energy Standards must be applied to all properties being rehabilitated with CDBG funds if (a) they are being counted towards HAP goals or (b) CDBG money is used to acquire the property for the purpose of rehabilitation.

At the time of publication, other HUD programs to which the Energy Standards apply are the Section 203(k) Home Mortgage Insurance program, which provides insurance on private home mortgage loans to owners of single-family buildings; and the Flexible Subsidy program, which provides supplemental federal financial assistance to the owners of troubled multifamily housing projects. Readers may refer to Chapter 5 for additional information on these programs.

Although application of the Energy

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tandards is currently required in the rograms listed above, readers should ontact the appropriate HUD Area ffices to keep abreast of changes in ese and other programs. Although *not* equired, local program officials can also se the Energy Standards to determine he cost-effectiveness of energy conserva- ion measures in other local programs, hould they wish to do so. Furthermore, t should be remembered that the Energy Standards provide for the minimum— ot the maximum or even the optimal— n energy-conserving measures.

PURPOSES OF THE GUIDE

Implementing the Energy Standards is an effective means of conserving the nation's energy resources and a sound financial investment for owners of single-family and multifamily buildings. The three basic purposes of this guide are:

- To clarify what the Energy Standards require in terms of energy conservation measures
- To explain the procedures for determining whether particular measures are cost-effective, that is, whether the measures will pay for themselves over a reasonable period of time
- To show how the Energy Standards can be implemented in rehabilitation programs

SCOPE AND USE OF THE GUIDE

This guide is intended for use by a wide range of people concerned with rehabilitation and energy conservation. Depending on their particular needs, individual readers may choose to read the entire guide or only specific sections. It is recommended, however, that everyone read the first part of Chapter 2, which explains what the Energy Standards require. The rest of the chapter discusses the procedures for calculating cost-effectiveness, first for single-family dwellings and then for multifamily buildings. Readers concerned solely with one or the other may want to read just those sections that are directly applicable to their own rehabilitation project.

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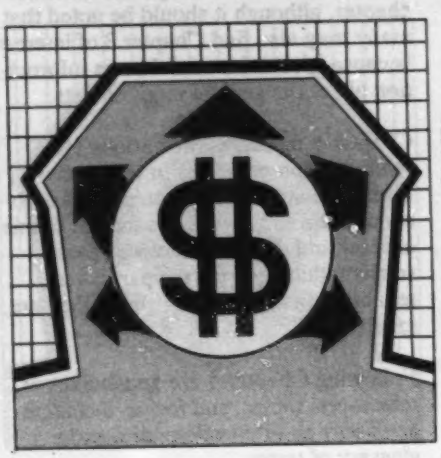
Chapter 3 describes in detail how to carry out the energy-saving requirements for single-family houses, while Chapter 4 does the same for multifamily buildings. Readers involved in single-family housing rehabilitation need only read the former chapter. Similarly, those readers concerned solely with multifamily projects need only read the latter chapter, although it should be noted that many may also find Chapter 3 of interest because it contains useful basic information about the general requirements.

Chapter 5 discusses the various HUD rehabilitation programs in which the Energy Standards are required. Readers should turn to the opening section of this chapter and then go on to read those sections that describe the particular rehabilitation program in which they are involved.

Following Chapter 5 are appendixes of references, tables, and forms, including an energy audit questionnaire, and a glossary of terms.

CHAPTER 2



The Cost-Effective Energy Conservation Standards

In just a decade, the price of home heating oil has increased from less than 19 cents a gallon to more than one dollar. The cost of electricity mirrors this increase, and natural gas may soon be as costly as oil. Those air drafts that were just a nuisance in the past now result in the loss of substantial sums of money.

To help reduce energy consumption, HUD requires minimum standards for weatherizing, or retrofitting, buildings in rehabilitation projects for which HUD provides low-interest loans or grants. The *Cost-Effective Energy Conservation Standards* help to specify the kinds of energy-saving improvements that it makes economic sense to carry out.

WHAT THE STANDARDS REQUIRE

The key word in the title of the Energy Standards is *cost-effective.* Energy conservation measures that are not cost-effective are not required as part of the Energy Standards. On the other hand, measures that *are* cost-effective must, within the guidelines set forth in the Energy Standards, be included in the project. It makes little sense to fix up a property without making it energy efficient.

An energy conservation measure is considered cost-effective if the savings in fuel costs (oil, gas, and electricity) offset the cost of the measure within a reasonable time. Tables and procedures for determining cost-effectiveness appear later in this chapter.

The Energy Standards provide guidelines for the kinds of energy-saving improvements that are required in rehabilitation projects, but not all requirements will apply to all situations. Such factors as the type of building, its location, the cost of energy, the nature of the project, fund limitations, and other considerations will all have a bearing on which measures will be cost-effective. The chief purpose of the Energy Standards is to provide a simple means of assessing the cost-effectiveness of individual energy measures.

SINGLE-FAMILY VERSUS MULTIFAMILY BUILDINGS

The Energy Conservation Standards distinguish between single-family structures and multifamily structures. These two kinds of buildings are different not only in number of dwelling units (a single-family building has up to four dwelling units, a multifamily building has five or more), but also in number and type of energy improvements that must be considered, specific procedures for evaluating energy efficiency, and the manner in which the cost-effectiveness

energy improvements is calculated.

lthough the number and type of energy nprovements that the Energy Standards quire are not identical for single-family nd multifamily buildings, some specific nprovements are required for *all* uilding types. These energy-saving easures have been determined to be lways cost-effective. The *general requirements for all buildings* include:

- Weatherstripping of doors and windows
- Caulking joints and cracks to close off openings to the outside
- When replacing HVAC systems (heating, ventilating, and air-conditioning):
  - Insulation of supply and return pipes and ducts in unconditioned spaces
  - Proper sizing of HVAC equipment

Single-Family Requirements

In addition to the general requirements noted above, certain other measures are required for single-family buildings if they will be *cost-effective for a particular building's rehabilitation.* Energy-conserving improvements that may fit into this category include:

- Insulation (in ceilings, floors, or walls)
- Storm windows
- Storm doors

Guidelines for determining whether a proposed improvement is cost-effective are presented later in this chapter. These guidelines include tables that take into consideration variables that will affect savings, such as local weather conditions, cost of fuel, initial cost of making the improvements, and the term and interest rate of a rehabilitation loan.

Essentially, adding insulation or installing storm windows and doors is required when: (1) the structural element where the energy improvement would be made (for example, wall or roof) is replaced or is accessible (or becomes accessible through the rehabilitation, for example, opening wall cavities for drywalling), and (2) the improvement is cost-effective.

Of course, adding storm doors and windows or attic insulation can also be cost-effective when the structural elements are not involved in the rehabilitation. Although *not required* in this instance, such measures should be considered if funds are available.

At the time of the initial rehabilitation inspection, the rehabilitation specialist will conduct an *energy review.* Similar to an *energy audit*, an energy review determines how energy is being used in a building, whether energy-conserving modifications are needed, and whether such modifications would be cost-effective. Energy-conserving improvements for single-family buildings and the energy review are discussed at length in Chapter 3.

Multifamily Requirements

In addition to the general requirements for all building types, various other measures are required for multifamily buildings *when such measures will be cost-effective for a particular building's rehabilitation.* Required improvements might include any or all of the following:

- Installing individual utility meters or checkmeters
- Putting in ceiling insulation
- Installing clock thermostats for units with individual heating units
- Installing storm windows or double-glazed windows
- Putting flow restrictors on showerheads and hot-water faucets
- Putting in thermostatic radiator valves
- Replacing incandescent fixtures in public spaces with higher-efficiency lighting
- Insulating water heaters located in unheated spaces
- Improving burners, controls, capacitors, and similar fixtures to increase the efficiency of mechanical systems and to lower fuel consumption

Note that not all of these improvements should or could be made on all buildings. The nature of the rehabilitation project, the amount of funds available, the particular construction of the building, and other factors will determine which modifications will be made. Energy improvements other than those listed may be made if they are cost-effective and are installed as part of the rehabilitation activity.

To evaluate how energy is used in a multifamily building, an energy audit must be conducted by either a private contractor, professional auditor, HUD Area Office Representative, the building owner, or another qualified individual. The energy audit will identify cost-effective energy conservation measures and specify what savings can be expected. Energy-saving measures for multifamily buildings and energy audits are discussed at length in Chapter 4.

CALCULATING COST-EFFECTIVENESS

For an energy conservation measure to be considered cost-effective, it must, over a predictable time span, recover at least its original cost through savings in fuel costs. In making this determination, a variety of factors may be taken into account: fuel consumption over the life of the improvement, rate of heat loss from the building or U-value (see Glossary), number of heating degree days and cooling hours, heating value or BTU content of fuel (see Glossary) and other variables.

Methods of calculating the cost-effectiveness of energy conservation measures differ for single-family and multifamily buildings. The calculation process for both types of buildings is discussed below.

Single-Family Buildings

To calculate the cost-effectiveness of energy conservation measures in single-family buildings, it is necessary to consider the following factors:

- The rate and term of the HUD rehabilitation loan
- Local fuel costs
- Local climate—that is, heating degree days and cooling hours (the latter when air-conditioning is used)

Table 1 FUEL PRICE/REFERENCE NUMBER
(Source: Federal Register, Vol. 44, No. 92, May 10, 1979)

Oil (cents/gallon)	29	33	37	42	46	51	55	64	73	82	91**
Gas (cents/therm)	23	26	29	33	36	40	43	51	58	65	72
Electricity (cents/Kwh)	1.6	1.8	2	2.3	2.5	2.8	3.0	3.5	4.0	4.5	5
Loan Index*	REFERENCE NUMBERS										
Above .900	1	2	2	3	4	5	5	6	7	8	8
.750 to .900	1	2	2	4	5	6	7	8	9	10	11
.600 to .750	1	2	3	5	6	7	8	9	10	11	11
Below .600	1	3	4	6	7	9	10	11	11	11	11

*From Loan Program Table (see Appendix A).
**Despite escalating fuel costs, the same level of cost-effectiveness is maintained. Current engineering procedures work with this figure.

- The current level of energy conservation features in the building

To simplify the task of determining whether an energy-saving improvement will be cost-effective, several tables have been developed incorporating the above factors. By referring to the specific calculation tables included here (Tables 1–6), it is possible to determine which energy-saving improvements will be cost-effective for a particular single-family building.

Determining the cost-effectiveness of energy conservation measures is a three-step process:

STEP ONE
Use Table 1: Fuel Price/Reference Number to find the correct Reference Number for a particular building. Note that the table takes into account the initial cost of the improvement, the life of the improvement, and the estimated first-year savings.

To obtain the correct Reference Number, two factors must be known: the price of fuel and the Loan Index for the type of loan involved.

Fuel Prices. If more than one fuel is used to heat the same building areas, use only the primary heating fuel in making calculations. If more than one fuel is used for separate purposes or to heat separate parts of the building, do separate calculations using the appropriate fuel price for each part of the building where rehabilitation is planned. Use the unit cost of fuel, which is expressed in cents per gallon for oil, cents per therm for gas, and cents per kilowatt-hour (Kwh) for electricity used in heating or cooling or both.

Use the unit cost paid for the last fuel purchased in the heating or cooling season. If unit costs exceed the highest cost shown on Table 1, use the highest cost column, for it will not significantly affect the calculation of cost-effectiveness.

Loan Index. To find this index, see the Loan Program Table in Appendix A. Look across the top of the table for the number of years in the life of the loan. Go down that column until opposite the interest rate of the loan. That number is the Loan Index. For example, if the loan is for 20 years at 3% interest, the Loan Index number is .521.

Note: When calculating the cost-effectiveness of energy-saving improvements for grant programs where the property is to be counted toward HAP goals, the 20-year 3% line of the Loan Program Table should be used. Although there is no cost to the homeowner for grants, this calculation will most nearly approximate the cost of public money for the purposes of calculating cost-effectiveness.

Reference Number. Refer back to Table 1. The correct Reference Number for the project will be the number in the column under the fuel price and across from the Loan Index number. If oil is 91 cents per gallon and the Loan Index number is .521, the Reference Number is 11.

STEP TWO
To find the correct Heating or Cooling Index, use Table 2 and/or Table 3. First find out the heating degree days and cooling hours for the particular area. This information is available locally from utility companies, weather stations, and fuel dealers. If local sources cannot provide this data, consult the tables in Appendixes B and C.

To find the Heating Index letter or Cooling Index number, locate the Reference Number (identified in Step One) and read down that column until opposite the degree days (Table 2) or cooling hours (Table 3) for the area. This will provide the necessary letter or number. For example, if the Reference Number is 11 and degree days are 6501

Table 2 HEATING INDEX
(Source: Federal Register, Vol. 44, No. 92, May 10, 1979)

REFERENCE NUMBER	1	2	3	4	5	6	7	8	9	10	11
DEGREE DAYS											
500–1500	A										
1501–2500											
2501–3500			B								
3501–4500											
4501–5500					C						
5501–6500						D					
6501–7500											
7501–8500							E				
8501–9500								F			
9501 and above										G	

Table 3 COOLING INDEX
(Source: Federal Register, Vol. 44, No. 92, May 10, 1979)

REFERENCE NUMBER	1	2	3	4	5	6	7	8	9	10	11
COOLING HOURS											
100											
300		1									
500											
700											
900				2							
1100											
1300						3					
1500											
1700							4				
2000								5			
2200										6	
2500											

to 7500, the Heating Index letter is G. With the same Reference Number and cooling hours at 900, the Cooling Index is 4.

STEP THREE
To determine what modification is cost-effective, consult Table 4: Recommended Insulation R-Values and Table 5: Recommended Storm Windows and Doors. R-value is the measure of a material's insulating ability or resistance to heat flow.

To determine the most cost-effective level of insulation for different parts of a structure, consult Table 4 as follows:

Ceilings. Read down from the Cooling Index and across from the Heating Index as identified in the previous step. That will give the recommended R-value. For example, if the Cooling Index is 3 and the Heating Index is B, the recommended R-value is R-26. (See, however, Note (a) below table.)

Walls. Simply read across from the Heating Index to the column labeled "Walls." If the Heating Index is C, the recommended insulation level is R-11 to R-13. (See, however, Notes (b) and (c) below table.)

Floors Over Unheated Spaces. Read over from the appropriate Heating Index letter to the column labeled "Floors." If the Heating Index is D, then the recommended insulation level is R-19.

In much the same way the insulation value was determined, find how many layers of glass are recommended for windows and whether to install a storm or thermal door by consulting Table 5 as follows:

Windows. Read across from the appropriate Heating Index letter to find the recommended number of layers of glass. The number "1" indicates no storm window is required. Number "2" or more indicates storm windows are required. Always use two layers of glass on skylights. (See also Note (a) below table.)

Doors. Read across from the Heating Index letter to determine if a storm door is recommended. (See Notes (b) and (c) below table.)

If the single-family building already has some insulation, an additional step must be added to the three-step method for calculating cost-effectiveness.

STEP FOUR
To determine whether *adding* more insulation is cost-effective, consult Table 6: Recommendations for Additional Ceiling and Floor Insulation.

Having determined the most cost-

Table 4 RECOMMENDED INSULATION R-VALUES
(Source: Federal Register, Vol. 44, No. 92, May 10, 1979)

Heating Index	CEILINGS (a)						WALLS (b)	FLOORS Over Unheated Spaces
	Cooling Index							
	1	2	3	4	5	6		
A	R-19						R-11 to R-13	0
B		R-26						
C				R-30				R-11
D					R-38		R-13 (c)	R-19
E								
F								
G								

(a) The addition of insulation to ceilings that presently contain insulation may not be cost-effective. If the additional insulation needed to conform to the recommendations is less than R-19, benefits are doubtful. (See Table 6 for further information.)

(b) For frame construction, the R-value of sheathing may be included in the insulation R-value of walls. Insulation is required only when interior or exterior wall covering is removed and an adequate vapor barrier is applied. When the existing wall contains any amount of insulation, additional insulation applied by blowing or pouring is not recommended.

(c) Extra insulation, up to R-19, is recommended where practicable under the conditions of Note (b).

ible 5 RECOMMENDED STORM WINDOWS AND DOORS
ource: Federal Register, Vol. 44, No. 92, May 10, 1979)

HEATING INDEX	GLASS	STORM DOOR OR THERMAL DOOR
	No. of Layers	
A	1	No
B	1	No
C	2	No
D	2	No
E	3 (a)	No (b)
F	3 (a)	No (b)
G	3 (a)	Yes (c)

) Three layers of glass are not usually cost-effective unless the existing windows are double-glazed or complete replacement of the sash is contemplated. If you are replacing the sash, you should put in insulating frames.
) Storm doors or thermal doors are recommended if the primary door is hollow-core or is over 25% glass.
) Applicable only to individual living-unit doors opening directly to the exterior.

ffective levels of insulation for ceil-gs and floors, it is now necessary to etermine the cost-effectiveness of dding insulation up to these levels. Existing insulation will obviously have n effect on the amount of new insulation hat it is cost-effective to install. The rst table in the chart is used for oil and as heat; the second table for electric esistance heat. Compare the recom-nended R-value from Table 4 with the mount of existing insulation to deter-nine the cost-effectiveness of adding nore insulation. For example, if the ecommended R-value for ceiling insula-ion is 30 and the existing insulation has n R-value of less than 9, insulation hould be added.

Examples of Calculating Cost-Effectiveness in Single-Family Buildings

EXAMPLE A: One Dwelling Unit
The owner of a 1,500-square-foot home ocated in Washington, D.C., has applied for a rehabilitation loan. The variables are:

- Fuel oil costs 99 cents per gallon to heat the house.
- Electricity costs 4.5 cents per Kwh to operate a central air-conditioning system.
- Washington, D.C., has a total of 4,224 heating degree days.
- Washington, D.C., has an average of 950 cooling hours.
- The loan is financed for 20 years at 3%.
- There are 3 inches of insulation in the attic ceiling.

STEP ONE
Find correct Reference Number. Check Appendix A—Loan Program Table to get the appropriate Loan Index number. For a 20-year loan at 3%, the Loan Index number is .521. With this number and the price of fuel, use Table 1 (page 8) to obtain a Reference Number. Use the extreme righthand column headed "91," since that is the highest fuel price. Reading down from there and across from .521 provides a Reference Number of 11. So does reading down from the electricity cost column.

STEP TWO
Find correct Heating or Cooling Index. Use Tables 2 and 3 (page9) to obtain the appropriate index letter and number. Given the local heating degree days of 4,224 and the Reference Number of 11, the Heating Index letter is E. Given the 950 cooling hours and the Reference Number of 11, the Cooling Index number obtained is 4.

STEP THREE
Determine what is cost-effective. Use Table 4 (page 10) to find what insulation is recommended in this situation. Read down from Cooling Index 4 and across from Heating Index E. The recommended insulation R-value for the ceiling of the house is 38. Read across from the Heating Index E to obtain an R-value of 13 for walls and 19 for floors over unheated spaces. Use Table 5 (above) to find out if these improvements are recommended. Heating Index E shows that storm windows are recommended but storm or thermal doors are not unless the primary door is hollow-core or more than 25% glass.

The information obtained can be summarized in chart form for easy reference. See the Summary Chart (page 13) for the Washington, D.C., project.

STEP FOUR
Determine cost-effectiveness of additional insulation. Use Table 6: Recommendations for Additional Ceiling and Floor Insulation (page 12). Since the Washington, D.C., house in Example A already has 3 inches of batt insulation in the ceiling (equal to an R-value of approximately 9, assuming 1 inch of existing insulation has an R-value of 3), it is not cost-effective to add insulation given the recommended R-value of 38.

EXAMPLE B: Four Dwelling Units
The owner of a 3,000-square-foot building located in Jacksonville, Florida, has applied for a rehabilitation loan. The building has four separate dwelling units. The downstairs apartments each have private exterior doors. The upstairs apartments are entered by going through an exterior door on the ground level, up

Table 6 RECOMMENDATIONS FOR ADDITIONAL CEILING AND FLOOR INSULATION

FOR OIL AND GAS HEAT		
IF THE EXISTING CEILING HAS AN "R"	**AND, THE RECOMMENDED "R" FROM THE TABLES IS**	**THEN**
<3	19	▪ add insulation where possible
≥3	19	▪ insulation not recommended
<7	26	▪ add insulation where possible
≥7	26	▪ insulation not recommended
<9	30	▪ add insulation where possible
≥9	30	▪ insulation not recommended
<9	38	▪ add insulation where possible
≥9	38	▪ insulation not recommended
IF THE EXISTING FLOOR HAS AN "R" (over unheated space)	**AND, THE RECOMMENDED "R" FROM THE TABLES IS**	**THEN**
<6	11	▪ add insulation where possible
≥6	11	▪ insulation not recommended
<6	19	▪ add insulation where possible
≥6	19	▪ insulation not recommended
FOR ELECTRIC RESISTANCE HEAT		
IF THE EXISTING CEILING HAS AN "R"	**AND, THE RECOMMENDED "R" FROM THE TABLES IS**	**THEN**
<6	19	▪ add insulation where possible
≥6	19	▪ insulation not recommended
<7	26	▪ add insulation where possible
≥7	26	▪ insulation not recommended
<9	30	▪ add insulation where possible
≥9	30	▪ do not insulate
<11	38	▪ add insulation where possible
≥11	38	▪ do not insulate

Table 6 (continued)

IF THE EXISTING FLOOR HAS AN "R" (over unheated space)	AND, THE RECOMMENDED "R" FROM THE TABLES IS	THEN
<6	11	▪ add insulation
≥6	11	▪ do not insulate
<6	19	▪ add insulation where possible
≥6	19	▪ do not insulate
≥ means greater than or equal to < means less than		

one flight of stairs to the upstairs landing. The stairwell and landings are not heated. The variables are:

- Fuel oil, costing 93 cents per gallon, heats the two lower apartments.
- Natural gas, costing 65 cents per therm, heats the two upper apartments.
- Electricity, costing 4.5 cents per Kwh, operates eight air-conditioning units.
- Jacksonville has a total of 1,239 heating degree days.
- Jacksonville has approximately 1,500 cooling hours.
- There is no insulation in the ceiling, the floor, or the walls.
- The loan is financed for 30 years at 9.5%

STEP ONE
Find the correct Reference Number.

Check Appendix A to get the appropriate Loan Index number. For a 30-year loan at 9.5%, the Loan Index number is .850.

With this number and the price of fuel, obtain a Reference Number applicable to the two lower apartments. On Table 1 (page 8) read down from the extreme righthand column and across from .850. The Reference Number is 11. Now obtain a Reference Number for the two upper apartments. Read down from the column where gas is listed at 65 cents per therm and across from .850. The Reference Number is 10, which is the same number in the electricity-cost column. The electricity Reference Number applies to all of the apartments.

STEP TWO
Find the correct Heating or Cooling Index. Given the local heating degree days of 1,239 and the Reference Number of 11, Table 2 (page 9) shows that the Heating Index letter is B for the two lower apartments. Using Reference Number 10, the Heating Index is also B for the two upper apartments. Given the 1,500 cooling hours and the Reference Number of 10, Table 3 (page 9) shows that the Cooling Index number is 5.

STEP THREE
Determine what is cost-effective. Use Table 4 (page 10) to find what insulation is recommended in this situation. Read down from Cooling Index 5 and across from Heating Index B. The recommended insulation R-value for the ceiling of the house is 30. Read across

SUMMARY CHART
▪ Location: Washington, D.C.
▪ Section 312 Rehabilitation Loan program
(Finance Terms, 30 years @ 3%)

Fuel type / Building Component	Oil @ $.99/gal	Gas @ $.55/therm	Electricity @ $.045 Kwh
Ceiling	R-38	R-38	R-38
Floor	R-19	R-19	R-19
Wall	R-13	R-13	R-13
Glazing (assume sash not to be replaced)	Double	Double	Double
Storm Door	Not Recommended	Not Recommended	Not Recommended

from Heating Index B to obtain an R-value of 11 to 13 for walls and 0 for floors over unheated spaces.

Use Table 5 (page 11) to find out if storm windows and doors are necessary. Heating Index B indicates that windows are not recommended; one layer of window glass is sufficient. Neither storm doors nor thermal doors are recommended.

Multifamily Buildings
When calculating the cost-effectiveness of an energy conservation measure for multifamily buildings, the following factors must be considered:

- The rate and term of the HUD loan
- The life of the improvement
- Estimated first-year savings
- Initial cost of the improvement
- The annual maintenance costs

Information obtained in the energy audit (see Chapter 4) required for multifamily buildings provides the basis for deciding whether a proposed improvement is cost-effective or not. A number of energy-saving improvements must be considered in the audit, although it may not be feasible or cost-effective to implement them all. Which improvements are made depends on the nature of the rehabilitation project, the design of the building, the mechanical operation, and other factors.

Energy-saving modifications that may be suitable must be analyzed to determine their cost-effectiveness. With multifamily buildings, cost-effectiveness is measured in terms of the *net present value* of the proposed modification.

Net Present Value. The net present value is simply the total anticipated savings over the life of the modification minus the cost of installation, maintenance, and financing (including initial purchase cost).

This can be stated in a mathematical formula: $N = X - Y$, where "N" is the net present value, "X" is the anticipated savings, and "Y" is the anticipated total cost.

A modification is considered cost-effective if "N" is greater than zero. Determining net present value indicates whether an improvement is cost-effective and also the *extent* to which an improvement may be cost-effective.

To determine the present value, the following information must be known:

- The initial cost of the modification
- The estimated first-year savings (see Appendix D)
- The annual maintenance cost of the modification
- The lifetime of the modification
- The rate and term of the loan

The tables in Appendix A provide the multipliers needed to project savings over the life of the modification ("X") and costs over the life of the loan ("Y").

Determining Savings. To calculate the anticipated savings over the life of a modification ("X"), first turn to Appendix A to find the correct "savings multiplier." Simply look down the column that is headed by the number of years in the life of the modification. (*Note:* The figures used to represent "the life of the loan" are also used for life of the modification.) If the life of the modification is 12 years, for example, the savings multiplier would be 9.82.

Next calculate net annual savings by subtracting annual maintenance cost from estimated first-year savings (see Appendix D). Then multiply net annual savings by the savings multiplier to get "X."

Determining Costs. Use the Loan Program Table in Appendix A to find the figure representing the terms of the loan. For example, given a loan of 30 years at 9.5%, the figure is .850. Multiply the initial cost of purchasing and installing a modification by .850 to get "Y," the total cost. Subtracting "Y" from "X" will then give the net present value ($N = X - Y$).

Example of Calculating Cost-Effectiveness in a Multifamily Building

Shown below are the details of a proposed energy-saving modification—the installation of storm windows—and the step-by-step procedure leading to the net present value.

(a)	Description of Modification	Install Storm Windows
(b)	Initial Cost	$51,920
(c)	Estimated First-Year Savings	$9,745
(d)	Annual Maintenance Cost*	$ 700
(e)	Lifetime of Modification	12 years
(f)	Length and rate of loan	30 years @ 9.5%
1.	Savings Multiplier Figure	9.82 (based on e)
2.	Loan Program Table Figure	.850 (based on f)
3.	Net Annual Savings	$9,045 (c−d)
4.	Obtain X (savings)	9.82 × $9,045 = $88,821.9
5.	Obtain Y (costs)	.850 × $51,920 = $44,132
6.	Obtain N (net present value)	$88,821.9 − $44,132 = $44,690
		N = $44,690 over 30 years

*Includes broken windows, cleaning, and caulking.

"N" represents the extent to which the installation is cost-effective. If "N" had been minus $44,690, the installation would not have been cost-effective. As it stands in the example above, however, the installation of storm windows is cost-effective.

CHAPTER 3

Carrying Out Energy-Saving Requirements for Single-Family Buildings

Homes consume about 20% of all the energy used in the U.S. Of this amount, about 50 to 60% is used for heat. Another 12 to 15% heats water and about 5 to 8% is used for air-conditioning. Lighting and appliances take from 12 to 20%.

Since so much of the energy goes for heat and hot water, that is where most savings can be realized and that is why weatherizing, or retrofitting, a house is so important. Just how much energy a particular house will use depends on many factors, including:

1. The climate where the house is located
2. The size and design of the building and its orientation to the sun
3. How well the building is currently insulated
4. How effectively the existing caulking and weatherstripping prevent air infiltration
5. Whether the building is air-conditioned
6. The occupants' energy consumption habits

Chapter 2 provided an overview of the general and particular requirements for single-family buildings. This chapter will help rehabilitation specialists, single-family property owners, HUD Area Office personnel, and others focus on ways of reducing heat loss and conserving energy in accordance with those requirements.

DEFINING A SINGLE-FAMILY BUILDING

A single-family detached house is a single dwelling unit that stands alone with four sides exposed. Single-family attached structures are dwellings such as duplexes (which are, in effect, two single-family houses that share a common wall) and rowhouses or townhouses (several single-family houses attached to each other).

In addition, there are large, usually older, structures consisting of two to four separate dwelling units that are structurally similar to the single-family detached house.

This chapter pertains primarily to single-family buildings with either a wood-frame construction (in which wooden studs, joists, and beams make up the building's frame) or a masonry construction. However, the calculation tables for single-family buildings are applicable only to wood-frame construction types

that have cavities in the walls where insulation may be placed.

ENERGY REVIEW

To pinpoint the areas in a single-family building that can benefit from energy conservation measures, an energy review is needed. The energy review is actually part of the rehabilitation inspection. While inspecting the structural condition of a building's roof and walls, for example, the person conducting the inspection would also make note of insulation needs, the absence of storm windows, and so forth. Upon completion of the combined rehabilitation inspection-energy review, he or she would use the calculation tables shown in Chapter 2 to determine the most cost-effective measures.

REDUCING HEAT LOSS

As noted in Chapter 2, HUD Energy Standards recognize that energy-saving improvements must be tailored to the type of building and the kind of rehabilitation being carried out. In all cases, however, the improvements must be cost-effective.

In most houses, the first practical step toward energy savings is blocking the flow of air into (infiltration) and out of (exfiltration) the building. To minimize this heat loss involves, among other things, caulking or weatherstripping all cracks or joints including those around windows and doors that are tightly shut. Reducing heat loss in this way is so clearly cost-effective, it is a general requirement for any project approval under the HUD rehabilitation programs mentioned in Chapter 1.

Some Facts About Air Flow

Heat flows from its source to a colder area. Hot air also rises. For these reasons, when houses are heated in winter, the hot air is always trying to get out and the cold air is always trying to come in. In summer, of course, the opposite is true. Air cooled by air-conditioning will be pushed outside by the flow of warmer air coming in.

Movement of heat results from *radiation, conduction,* or *convection,* or some combination of these three.

Radiation occurs when a source of heat, such as the sun or a hot radiator, sends out heat waves. Heat radiation through glass windows is welcomed in the winter, but in the summer, it can introduce unnecessary heat into a building.

Conduction is the flow of heat through one physical material to another or just out into the air. Insulating materials help to reduce heat conduction substantially.

Convection occurs because warm air is lighter than cold air and will move upward. As cold air becomes warm, it rises. More cold air moves in to replace it, and it too becomes warm and rises. An air current develops that moves heated air around a space in a predictable direction. For this reason, most heating devices are put in or close to the floor.

Combinations are frequently involved in the movement of hot air. Radiators radiate heat and warm an entire room due to convection. Radiators also conduct through their metal casing. In the winter, heat radiated by the sun and conducted through glass windows can be a welcome additional source of warmth for a home.

Studies have shown that a substantial amount of indoor heat is lost as it moves through cracks and openings in the building, including electrical outlets and switches in outside walls. Major heat losses also result from convection as warm air moves up furnace flues and fireplace chimneys. Caulking and weatherstripping are two energy-saving improvements designed to reduce this heat loss that causes high heating and cooling bills.

Caulking*

Caulking is a very simple way to greatly reduce unwanted air flow. Filling cracks and openings in outside walls with a caulking compound is an easy, economical way to realize large savings in energy costs. Homeowners can maximize their savings, of course, by applying caulking themselves rather than paying someone else to do it. It is not a difficult job.

When selecting caulk, note that materials of different quality are available. There are three basic types of caulk. *Oil- or resin-based caulk* is the least expensive, but it is also the least effective. It is readily available and will bond to most surfaces, but it tends to harden and crack after 2 to 4 years. Some how-to guides advise against using it.

Latex and butyl-based caulks are a little more expensive, but they are much more durable than oil-based caulks. They usually last from 6 to 20 years and hold up well to building expansion and contraction caused by changes in temperature.

Elastomeric caulks, such as polyurethanes, silicones, or polysulfides, are the most durable and most expensive caulks. They will last 20 years or more and are exceptionally good at withstanding the type of expansion and contraction caused by extreme temperature fluctuations. Elastomeric caulks can also be used with filler material, such as oakum, caulking cotton, sponge rubber, or fiberglass, to close large cracks.

Most caulking compound comes in tubes. Directions on the tube tell how to cut the nozzle and apply the compound with a caulking gun. Caulking guns are inexpensive and readily available at hardware stores and building-supply houses.

Apply caulking to all fixed joints, for example:

- Around windows and doors where frames meet siding

*This is a general requirement.

- Between windowsills and siding
- Between plates and foundation
- Around all holes for pipes, ducts, or electric conduits through outside walls
- Around all holes through a wall separating heated and unheated spaces, such as attached garages, storerooms, or attics
- Between unheated porches and the main body of the house
- Where the chimney or masonry meets the siding
- Around the outside of water faucets

This list is not exhaustive. For more information, refer to the reference guides suggested at the end of this chapter.

WEATHERSTRIPPING*

Weatherstripping, like caulking, reduces unwanted air flow. Caulking is applied to fixed joints; weatherstripping is applied to the moving parts of doors and windows. Weatherstripping comes in strips of thin-spring metals, rolled vinyl, felt sweeps, or foam rubber. These materials help to seal windows and doors tightly to prevent air leaks. While most weatherstripping can be applied to both doors and windows, some types are designed to be used on either one or the other.

Thin-spring metal weatherstripping can be used on both doors and windows. Though it is somewhat difficult to install, it is the most durable (and most expensive) type of weatherstripping. It is virtually invisible when in place.

Rolled, or flexible, vinyl is durable and easy to install. It is made with a metal backing for doors and without a backing for windows.

Felt and foam-rubber weatherstripping are inexpensive and easy to install, but they are not very durable. They tend to shrink after a short period of time. Some types have a self-adhesive backing. These types should never be used where friction occurs.

*This is a general requirement.

Door sweeps, consisting of vinyl or felt-backed metal strips, can be applied to the bottom of doors to reduce air infiltration.

Many how-to guides are available that provide detailed, step-by-step instructions for installing weatherstripping. Some of these guides are listed at the end of this chapter.

INSULATING REPLACEMENT HVAC SYSTEMS*

Because of conduction, as much as 40% of heating and cooling energy can be lost through uninsulated pipes and ducts in cold areas. For this reason, *when replacing heating, ventilating, and air-conditioning systems, HUD Energy Standards require that all pipes and ducts be insulated.*

All supply and return pipes and ducts in the new HVAC system should be insulated to the following specifications whenever they run through unconditioned spaces: duct insulation must be R-4 or greater, and pipe insulation must be R-2 or greater. (Refer to the section on insulation later in this chapter for an explanation of R-values.)

It is not difficult to insulate pipes and ducts. Duct insulation generally comes in blankets 1 or 2 inches thick. A vapor barrier should be attached to the exterior side of insulation for air-conditioning ducts. Seal the insulation joints tightly to stop condensation. Before you insulate, seal all duct seams tightly and tape any leaks. Various how-to guides discuss the application of pipe and duct insulation. (See references at the end of this chapter.)

Pipe insulation is available either as urethane foam or fiberglass. *Urethane foam* can be purchased as a foam tube 6 or 8 feet long. To apply, simply make a slit along the side of the tube and slip it over the pipe, sealing it with duct tape at the joint.

Fiberglass pipe insulation often comes with a paper barrier backing. This backing may not be suitable for use as a vapor barrier. Be sure to read the instructions. To apply fiberglass insulation, make a slit down the length of the side of the fiberglass and wrap it around the pipe. Seal the joints with duct tape or the paper backing.

Unlike heating and cooling systems, in a home hot-water pipes for domestic systems are used only sporadically. A rehabilitation specialist should determine whether it is feasible and cost-effective to insulate the hot-water pipes.

HIGH-EFFICIENCY HVAC SYSTEMS*

A HVAC system that is improperly adjusted or is poorly suited to a building may waste an enormous amount of energy. For instance, a system that is "oversized" operates inefficiently. An oversized system is one that produces more heat or air-conditioning than the space it is servicing requires. For example, if a heating system runs on a steam boiler, it would be inefficient to boil more water than is needed to heat the house. The oversized system burns fuel and heats up the room too quickly, and then shuts off. Excess heat that ordinarily would have been pushed into the room by a properly sized system now merely remains in the pipes because the system is turned off. Often this excess heat is lost through the furnace flue or simply cools down in the pipes. Furthermore, the constant on-and-off action of the system wastes fuel. In contrast, a properly sized system that matches building needs may run longer but will use less fuel because it burns fuel at a slower rate.

*This is a general requirement *only if* the system is being replaced. It is desirable at other times if the pipes are accessible.

*This is a general requirement *only if* the system is being replaced. It is desirable at all times if the present system is oversized.

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For these reasons, the Energy Standards require replacement HVAC systems to have high-efficiency systems and burners that are not oversized by more than 15%. A competent installation contractor can determine which system is most efficient for a residence.

The efficiency of a system is often affected by its size, relative to the building needs, as well as by any changes made to save fuel. Any energy-conserving improvement—such as installing insulation in ceilings and walls or adding storm windows—can cause a heating system to become oversized. It is a good idea to recheck the system after making modifications and correct any oversizing. Oil or gas system parts can sometimes be repaired or replaced at minimal effort and expense. For instance, the amount of fuel consumed by an oil furnace may be reduced as much as 20% simply by repairing a faulty burner nozzle or by installing a smaller one. Although such modifications do not require replacement of the entire HVAC system, they are generally cost-effective and should be considered.

ADDITIONAL ENERGY CONSERVATION MEASURES*

The Energy Standards require such thermal improvements as the installation of insulation and storm doors and windows only if it is cost-effective and feasible to do so. (See Chapter 2.) If the proposed rehabilitation requires the removal of interior or exterior walls, ceilings, or floor coverings, the level of insulation may need to be upgraded. If it involves replacing window sashes or similar extensive repairs, storm windows and doors may also need to be added.

Although the Energy Standards only require that these measures be taken in that portion of the building being rehabilitated, consideration should also be given to adding insulation in attics and installing storm doors and windows where and whenever it is cost-effective.

*Required only if cost-effective.

Although *not* required if the structural component is not affected, such improvements can save a considerable amount of energy and reduce fuel costs significantly.

In most circumstances, if the energy savings do not pay for the required improvements over either the term of the loan or the useful life of the improvement (whichever is shorter), the improvement should not be made. (See Chapter 2 for procedures to determine cost-effectiveness.)

Insulation*

An adequate level of insulation will benefit a house or building in many ways. Insulation slows down the rate of heat conduction, keeping heat in living areas for longer time periods. As a result, less heat is used in winter and air conditioners usually operate for shorter periods in summer without sacrificing comfort.

Adequate insulation may also affect the efficiency of heating and cooling systems and permit "downsizing." For instance, more efficient furnaces, furnace flues, air conditioners, and duct systems may be installed. Smaller, more efficient units or downsized nozzles may be possible to use to improve efficiency and savings. Additionally, insulation helps to soundproof. Because it is usually fire resistant, insulation may serve as a deterrent to the spread of fire.

The type of insulation and the best installation method may vary from one case to another. The level of effectiveness of an insulation material is stated as its R-value. R-value is the degree to which a material is able to resist heat flow. The higher the material's R-value, the greater is its ability to insulate. Building materials as well as insulation materials have different R-values. These must be considered in determining the total thermal resistance of a building.

*This is required if cost-effective and when rehabilitation involves that portion of the building to be insulated.

Most insulation packages list the R-value of the contents in compliance with Federal Trade Commission (FTC) regulations. However, for insulation previously installed, the R-value can be estimated by first measuring in inches the thickness of the insulation. This figure is then multiplied by 3.0 for an approximate R-value.

There are several types of insulation: batts and blankets, loose-fill, and rigid board.*

Batt and blanket insulation, like most home insulation, is made of mineral fibers, either processed fiberglass or rock wool. Batts and blankets are used to insulate unfinished attic floors, unfinished attic ceilings, unfinished walls, and the underside of floors. This type of insulation is best suited to a standard joist or rafter spacing of 16 or 24 inches. Both batts and blankets come in widths of 15 and 23 inches. They are available either with or without a vapor barrier backing. Batts generally come in sections 4 or 8 feet long. Blankets come in long rolls that are cut to the desired length for installation.

Loose-fill insulation is either poured in or blown into floors or walls. Poured-in loose-fill is made from cellulosic fiber, rock wool, fiberglass, granulated cork, vermiculite, slag, and other fibers. It is used to insulate unfinished attic floors. Blown-in loose-fill is made from cellulosic fiber, rock wool, or fiberglass. It is used to insulate unfinished attic floors, finished attic floors, and finished frame walls. It can be poured into the cores of masonry blocks. Loose-fill insulation is the best type to use for irregularly spaced joists or rafters or in areas where there are many obstructions. If an existing wall has any insulation, or if a vapor barrier does not exist, or if not being made accessible, the Energy Standards do not require blowing or pouring additional insulation.

*The U.S. Consumer Product Safety Commission has banned the use of formaldehyde foam insulation.

As loose-fill insulation, *cellulosic fiber* has approximately 30% more insulating value than rock wool for the same number of inches installed. It is chemically treated for fire and moisture resistance. Check the bags, which should be clearly labeled to show the material meets federal specifications for fire resistance.

Rigid board insulation is made from fiberglass, polystyrene, and polyurethane. It is usually 10 to 24 inches wide and 48 inches long and comes in a variety of thicknesses with a high insulating value. This type of insulation is in basement walls, on the outside of stud walls as sheathing, or as perimeter insulation on masonry walls and in cathedral ceilings. Polystyrene and polyurethane rigid board installed on the inside wall surface must be covered by ½-inch gypsum wallboard for fire resistance and should be installed by a reputable contractor.

Storm Doors and Windows*

A rehabilitation specialist will determine whether the application of storm doors and windows is feasible and cost-effective. Storm windows are usually a good idea. However, three layers of window glass are not recommended. Three layers are cost-effective only when existing windows are double-glazed or when the sash is completely replaced. If the sash is replaced, insulating frames should be installed in very cold areas.

A storm door or thermal door is recommended if the primary door is hollow-core or if it is more than 25% glass. A storm door is a glass door that is installed outside of the primary door. A thermal door is a tight-sealing door made with insulating material and is installed in place of the primary door.

Storm doors and windows reduce heat loss and air infiltration by creating a dead air space between themselves and the primary door or window.

Storm doors and windows may be installed in several ways. Make-it-yourself doors and windows are assembled by the homeowner and then installed. Ready-made doors and windows come already assembled and are purchased in the most suitable size. Custom-made doors and windows are specially made to the exact measurements. Custom-made windows and doors fit best and last longer than the other types, but they are more expensive. Regardless of the type installed, storm doors and windows should fit well and be properly caulked and weatherstripped.

If it is not possible to install storm doors and windows throughout the building, they should be installed on the sides facing north and toward the prevailing winds, where they will be most cost-effective. In existing houses, storm windows tend to be more cost-effective than double-pane windows for two reasons: They reduce air infiltration around the window sash, and they are less expensive to install.

A number of types of storm windows are available.

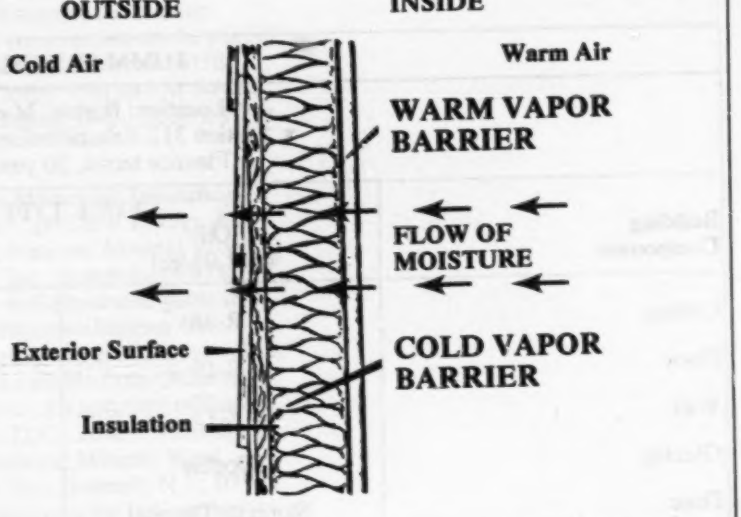
Single-pane glass, plastic sheet, or rigid plastic storm windows are easily installed in the fall and removed in the spring.

Triple-track glass or combination storm windows are used for double-hung or sliding windows. These come with screens and can be easily opened and closed for ventilation. (Double-track units without screens are available at lower cost.) If installed properly, plastic storm windows are as effective as glass ones.

MOISTURE PROBLEMS

After thoroughly insulating and weatherizing a house, moisture problems could occur because all the leaks through which moisture could escape have been closed off. In the home, people generate moisture from bathing, cooking, and body heat. There is always moisture in the air. The trick is to stop it from condensing. Vapor barriers and ventilation are two simple answers to this potential problem.

Figure 1 FLOW OF MOISTURE IN A BUILDING



*This is required only if cost-effective and when rehabilitation involves that portion of the house.

Vapor Barriers
A vapor barrier is a specially treated paper, thin plastic sheet, or low-permeance paint that prevents condensation of water vapor inside a house. The term "vapor barrier," which is commonly used in construction, is somewhat misleading. Vapor barriers do not completely bar the transmission of water vapor. They are actually vapor-resistant membranes that should have a vapor *permeance* (the rate that moisture can pass through materials) of not more than one *perm* (see Glossary). For this reason, the term "vapor retarder" is often used for vapor barrier.

Moisture generated inside tries to move out of the building. (See Figure 1.) Vapor barriers are important because they stop this moisture in a warm area where it will not condense. For this reason, vapor barriers should be applied to the plasterboard or drywall of a wall or ceiling next to existing insulation and on the warm side of insulated floor sections over crawl spaces.

If additional insulation is put in, be sure that a second vapor barrier is not applied between layers of insulation. A second vapor barrier would trap moisture between layers of insulation and eventually ruin it. Moisture that is trapped within a building wall could also cause the structural members to rot. Consult an energy auditor or rehabilitation specialist for the proper use of vapor barriers in ceilings.

Ventilation
Proper ventilation in attics is important to remove excess moisture from the house. If an attic has insulation but no vapor barrier, a good rule of thumb for determining the minimum ventilation area is to take the square footage of the floor area of the attic and divide it by 150. Thus a 1,500-square-foot attic should have 10 square feet of clear, unobstructed ventilation area (1,500 ÷ 150 = 10 sq ft). If the attic has both insulation and a vapor barrier, find the ventilation area by dividing the floor area by 300 (for example, 1,500 ÷ 300 = 5 sq. ft.)

Attic ventilation works best with two or more vents to permit circulation of air. If possible, use a high and a low vent—for example, an eave or soffit vent at the bottom of the roofline and a gable or ridge vent in the upper part of the roof.

CASE STUDY

The following case study is intended to show how rehabilitation specialists determine the best application of energy-saving improvements to a rehabilitated dwelling.

Examining a Single-Family Home
The owners of a single-family home in Boston have applied for a Section 312 Rehabilitation Loan. They have been told that they are eligible for a loan at 3% for 20 years. A rehabilitation specialist has undertaken an energy review, and has obtained the following information.

- Heating oil at $1.05 per gallon is used to heat the house.
- Electric air-conditioning at $0.08 per Kwh is used to cool the house.
- Boston has a total of 5,634 heating degree days.
- Boston has a total of 800 cooling hours.
- The current ceiling insulation has a value of R-2. There is no insulation or vapor barrier in the walls and no insulation in the floor over the basement.

The rehabilitation specialist also noted that the basement and attic were not heated and the windows are all single-glazed. No replacement of mechanical equipment is recommended at this time. Using this information and the calculation tables shown in Chapter 2, the rehabilitation specialist develops the following summary chart:

SUMMARY CHART

- Location: Boston, Massachusetts
- Section 312 Rehabilitation Loan program (Finance terms, 20 years @ 3%)

Building Component	FUEL TYPE Oil @ $1.05/gal	Gas @ $0.55/therm	Electricity @ $0.08 Kwh
Ceiling	R-38	R-38	R-38
Floor	R-19	R-19	R-19
Wall	R-13	R-13	R-13
Glazing	Double	Double	Double
Door	Storm or Thermal	Storm or Thermal	Storm or Thermal

Planning the Rehabilitation
The proposed rehabilitation involves the removal of coverings for three exterior walls and most of the ceiling. Removal of the floorboards over the unheated basement will also be necessary. Replacement of the primary storm sashes is contemplated where exterior walls will be removed. A vestibule is planned for the front entrance, which should help to conserve energy.

Applying Energy-Saving Improvements
Given the proposed rehabilitation and the recommended energy-saving improvements, the rehabilitation specialist can make the following recommendations concerning the application of improvements.

Ceilings. Although the ceiling does not have a vapor barrier between the rock lath and current insulation, if adequate ventilation is provided, a vapor barrier can be omitted. Since the recommended insulation level is R-38 and the current insulation value is R-2, Table 6 (page 12) indicates that as much insulation as possible should be added up to the R-38 level. Thus it is cost-effective to add approximately 9 inches of batt and blanket insulation up to the depth of the structural member.

Walls. Since no interior vapor barrier and no insulation currently exist, an effective vapor barrier and insulation should be installed up to the level of R-13. Loose-fill or batt and blanket insulation could be used.

Floor (Over Unheated Space). The recommended insulation level of R-19 can be achieved within the depth of the joists. However, due to the presence of electrical wiring, piping, and bracing in the basement ceiling, the installation of insulation might not be cost-effective. Installation cost-estimates should be reviewed before a decision is made.

Windows. Since the primary sashes for windows on three walls are going to be replaced, double- or triple-glazed windows could be added. However, while double-glazing reduces conductive heat loss, it is not as effective at reducing air infiltration as storm windows. Therefore, storm windows should be applied to all windows.

Door. The proposed vestibule prevents the need for a storm or thermal door at the front entrance. However, for side and back entrances, storm or thermal doors should be installed.

Building Envelope. Caulking and weatherstripping should be applied wherever it is nonexistent or inadequate. Since the building is located in a cold climate, a durable elastomeric caulk should be applied. Spring bronze weatherstripping is recommended for doors and windows since it is the most durable type.

RECOMMENDED READING

Several weatherization guides are available to help make homes energy efficient. The following three booklets are particularly useful.

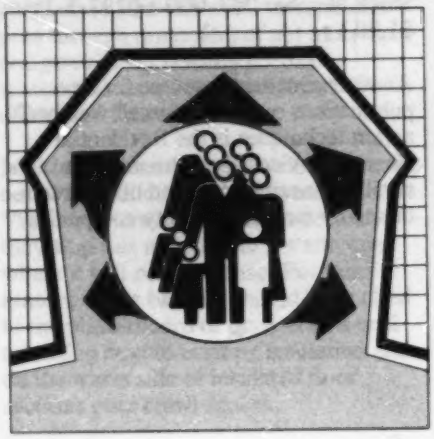
Insulation Manual: Homes/Apartments. 2nd Edition (Prepared by NAHB Foundations, Inc., Rockville, Maryland, September 1979, 148 pages). This detailed guidebook discusses all aspects of insulation. A variety of installation techniques are covered, most of which assume some basic knowledge of construction on the part of the reader. (Available from NAHB, Publication Order, 15th and M Streets, N.W., Washington, D.C., 20005. Price $10.00.)

How to Save Money by Insulating Your Home. (Federal Energy Administration, National Mineral Wool Association, Inc., September 1974, 16 pages). This well-illustrated guide discusses installation techniques for weatherstripping and caulking as well as insulation. (Available from Office of Weatherization, Department of Energy, Washington, D.C., 20461. Also available from National Mineral Wool Association, Inc., Summit, N.J., 07901. Price 30¢, discounts for large orders.)

In the Bank or Up the Chimney? (Department of Housing and Urban Development, April 1975, 72 pages). This guidebook provides simple, detailed instructions for either contractor or do-it-yourself installation of caulking, weatherstripping, storm doors and windows, and insulation (attics, floors, and walls). (Available from Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., 20402, Stock Number 023–000–00297-3. Price $1.70.)

Another excellent resource for free publications on do-it-yourself weatherization techniques is the Residential Energy Services Department (or a similar consumer-oriented office) maintained by most local utility companies.

CHAPTER 4



Carrying Out Energy-Saving Requirements for Multifamily Buildings

Owners of rental properties view their buildings as financial investments. They look to their properties as a source of income and as an important part of their economic livelihood.

Net income, of course, decreases or increases as fixed and operating expenses rise or fall. For this reason, owners strive to minimize these expenses. The Energy Standards offer multifamily building owners an opportunity to reduce operating expenses substantially at the same time as they are upgrading their properties through rehabilitation. Cost-effective energy conservation measures, even those that may seem expensive now, can save owners thousands of dollars in the future.

REQUIRED ENERGY-SAVING MEASURES

As discussed earlier in this guide (see Chapter 2), such basic energy-saving measures as weatherstripping, caulking, and insulating and proper sizing of replacement HVAC equipment are general requirements for both single-family and multifamily buildings. In addition, the Energy Standards require a variety of other energy-saving improvements when the energy audit (discussed later in this chapter) indicates that they will be cost-effective for a particular multifamily building and when sufficient funds are available to implement them. These improvements are listed in Chapter 2 on page 7.

This chapter will help developers, owners, housing officials, HUD Area Office personnel, and local rehabilitation specialists to carry out energy audits and related calculations, and to implement in multifamily buildings the cost-effective measures identified by these audits.

Deciding Which Energy-Saving Improvements to Make

As pointed out in Chapter 2, energy conservation measures other than general requirements must be shown to be cost-effective and feasible on an individual-case basis. In some instances, a building may be in need of a great number of improvements—those listed on page 7 and others as well. Under such circumstances, if funds are available and if the proposed improvements are shown to be cost-effective and feasible, given the nature of the rehabilitation, the owner must be able to implement all the recommended energy conservation measures. When there are inadequate funds or other reasons why it

is not possible to carry out all the measures, the owner sets priorities by selecting the most appropriate measures based on economic factors, degree of cost-effectivenes, and the energy auditor's recommendations. The final decision must then be approved by HUD as part of the loan or grant application process.

THE ENERGY AUDIT

The energy audit is basically a step-by-step analysis of a building's energy consumption. The various data gathered in an audit can be used to calculate whether a given energy-saving measure will or will not be cost-effective in a particular building.

Even though a wide range of energy-saving measures may be identified through an energy audit, the number of measures that will actually be implemented depends on the kind of rehabilitation being carried out, the way the building is designed, and various other factors. The audit report, complete with all pertinent calculations, is submitted with the necessary application forms to the administrators of the particular rehabilitation program. A program official and the building owner determine whether project funds will cover some or all of the proposed energy-saving measures.

Choosing an Energy Auditor

An energy audit for a multifamily building may be conducted by a professional energy auditor, a private contractor, a local rehabilitation specialist, a HUD representative, or another qualified individual. The building owner may also perform the audit personally if she or he has the expertise needed to carry out the required inspections and do the necessary cost calculations. To avoid hiring unqualified or inadequate auditors, building owners who decide to use a professional energy auditor should obtain input and recommendations from several sources. Utility companies and energy equipment suppliers will be able either to provide trained energy auditors for multifamily buildings or to direct the building owner to sources of qualified individuals. The State Energy Office also can assist owners in finding a professional energy auditor. Some states now have auditor certification programs, and a list of certified auditors may be available.

When selecting an auditor, there are several guidelines to keep in mind.

Bids. As audit costs generally range from $.05 to $.15 per square foot, a comprehensive audit can add up to a sizable amount of money. Remember though that the lowest bid is not necessarily the best. The auditor's qualifications and experience must be carefully considered. Furthermore, be sure to compare bids for *identical* audits. Obviously, a once-over-lightly audit may be cheaper than a thorough, painstaking audit, but it will have far less value for the owner.

Timetables. A prospective auditor should be willing to complete the audit within a specified time period. Remember that the sooner the audit is performed, the sooner the rehabilitation loan application can be submitted.

References. Always request and speak with several references—past clients who have used the services of the particular auditor. Promptness, reliability, and accuracy are all factors to check.

Résumés. Examining an auditor's résumé is one way to learn about his or her background and experience. The decision to use a particular auditor, however, should never be made on the basis of a résumé alone.

Samples. Ask for a detailed written description of what the audit will cover along with a sample of an audit that was actually performed. How thorough was the job? How useful is the report? The answers to these kinds of questions will help when comparing one auditor with another.

Communication. From the beginning, make clear to prospective auditors exactly what is needed. Specify that the audit will be used as the basis for a HUD rehabilitation loan application and that certain cost calculations will be required. Only by understanding the building owner's needs can an energy auditor accurately estimate and perform a job.

The Audit Procedure

In most instances, the auditor begins by discussing with the building owner past fuel bills and maintenance records. Problem areas already identified by the owner would be pointed out to the auditor at this time.

The auditor then conducts a careful, step-by-step "walk-through" inspection of all areas of the building, including a thorough examination of the building's heating and cooling systems and mechanical and electrical operation. See Appendix E for a detailed sample of an audit of a multifamily building.

Note, however, that not every auditor will conduct an inspection or perform calculations in precisely the same way. Furthermore, while energy audit procedures are similar in different parts of the country, they are not identical. Nevertheless, the energy conservation items identified in Appendix E represent the basic conservation measures most auditors will focus on. It may be used to determine the need for those measures listed on pages 16–20 in the absence of another, more preferable format.

CALCULATING COST-EFFECTIVENESS

Once the energy auditor identifies the measures that are needed, she or he then determines their cost-effectiveness using the calculation procedures described in Chapter 2 to compute net present value (see pages 7 - 11). Of course, the energy auditor will be performing these calculations not merely for one measure (as in the storm-window example in Chapter 2 on page 14), but for all proposed improvements.

Once the audit inspection has been completed, two forms are used to facilitate these calculations—a Cost and Savings Information form and an Audit Calculation Worksheet. In addition, the Audit Calculation Worksheet may be submitted to HUD along with the audit report as part of the rehabilitation loan application. Samples of these forms (pages 26–27) are included as part of the following detailed case study of a multifamily-building audit.

CASE STUDY

The case study that follows is intended to illustrate how energy audit procedures and related calculations would be carried out. It should be kept in mind that individual situations will vary in complexity depending on such factors as how old a building is, how well it has been maintained, and, of course, what kind of rehabilitation is planned.

Examining the Cambridge House Apartment Complex

The Cambridge House Apartments are located in the South End area of Boston, Massachusetts. The complex consists of seven buildings of masonry construction. They have four or five stories and a flat roof with a built-up tar and gravel surface. Other common features include a 4-foot crawl space between the ceiling of the top floor and the roof deck; single-pane, double-hung windows on metal tracks, with no storm windows; and metal and glass single-swing doors that open out from a central vestibule.

The buildings are old and in need of substantial repair and refurbishment. Since rehabilitation of the complex would benefit Cambridge's many low- and middle-income tenants, the owner will apply for HUD assistance in financing the necessary work. At this point, the owner anticipates financing the rehabilitation with a 30-year, 9.5% loan.

The Energy Audit. An energy auditor, hired by the owner, has completed a walk-through audit of the complex using a format much like the one shown in Appendix E. In addition, the auditor has examined past fuel consumption and maintenance records and has spoken at length with the owner and building personnel.

The audit identified a number of energy-saving measures that might be carried out in the process of rehabilitation. These measures could save the owner thousands of dollars in the future. However, the audit report indicated that not all of the possible energy-saving measures would necessarily be cost-effective.

Heating System Considerations. In conducting the energy audit, the auditor devoted a great deal of time to an examination of Cambridge's heating system. Since heating system inefficiency can cause extraordinary fuel waste—and needless expense for the owner—such time is always well spent.

Cambridge's heat is supplied by steam boilers located in the basements of the buildings. Steam heat is allocated periodically by means of automatically controlled valves whose operation is governed by the outside temperature. A timing device allows for a nighttime temperature setback. This device currently provides for a night setback from 3:00 A.M. to 6:00 A.M. This setting is designed to accommodate the varying working hours of the residents. Furthermore, since heat is available only intermittently, past operation has shown that a limited setback is necessary to maintain acceptable minimum temperatures.

The auditor discovered that at present there is no real attempt to regulate indoor temperature. Indeed, building personnel noted that temperatures in different apartments in the winter ranged anywhere from 72° F to a tropical 85° F degrees!

Since heat is controlled by one central timer for each building, the individual tenant has no ready way of maintaining a comfortable apartment temperature. In addition, because heat is delivered to different apartments without taking into account the specific heating needs of any one apartment, some units are regularly overheated and tenants must compensate by opening windows! The inefficient and ineffective operation of the heating system is further complicated by the fact that Cambridge's buildings use a one-line steam system with valves that have only two positions—open or closed. In other words, no partial opening is possible to restrict heat delivery.

Considering Various Energy-Saving Measures

The energy auditor's study pointed out a number of possible conservation measures. Some were relatively inexpensive; others would require a significant capital outlay. Most, but not all, would be cost-effective.

Limiting Water Flow. None of the Cambridge apartments currently use water-flow reducing devices. Inexpensive flow-restricting showerheads and faucet aerators can significantly decrease the amount of water used. This represents a double saving: lower water bills *and* lower bills for heating hot water.

Adjusting Heat Distribution. Cambridge's current heating system is not an easy one to regulate. The auditor noted that zoned heating would be an effective solution to the problem of varying apartment temperatures and overheated apartments. However, establishing an effective zoning system would be costly.

With a single-pipe steam heating system, thermostatically operated steam valves could be installed on inlet pipelines, and temperature-operated air vents could be installed on radiators. (A two-pipe system would require the additional installation of temperature-controlled condensate traps on return pipelines.) In this way, sections of a building, individual apartments, or even individual rooms could be independently regulated according to heating needs. (*Note:* For such a system to operate effectively,

steam would have to be available at all times.)

Aside from such heating system modifications, the auditor noted that the current system could be "fine-tuned" by locating the apartment in each building with the greatest heating requirement and adjusting heat delivery so that the temperature in that apartment consistently registers between 68 and 70° F.

(*Note:* Although it was not the case at Cambridge, in some situations only one apartment or one floor is significantly difficult to heat, while the others are more or less consistent in their interior temperature. When this is the case, it may be worthwhile to consider some special adaptation, such as additional insulation for that one apartment or floor, rather than raising the temperature of the entire building to accommodate a limited need.)

The auditor also suggested exploring the possiblity of increasing the night setback period, if possible to at least 6 hours.

Applying Caulking and Sealants. The auditor recommended that caulking and sealants be added or repaired as appropriate and that this process be established as part of the annual maintenance routine.

Applying Weatherstripping. At the present time, maintenance personnel install foam weatherstripping principally in response to tenant request. The auditor recommended that all doors and windows be weatherstripped as part of routine maintenance procedures. Furthermore, since foam weatherstripping tends to crack and deteriorate over time, it was suggested that a more durable type of weatherstripping, such as spring bronze or vinyl bulb (see Glossary), might be advisable.

Installing Storm Windows. The auditor recommended that storm windows be added to all windows in the Cambridge complex. Windows consisting of insulating glass (that is, double-glazed windows) were also considered. However, double-glazing would reduce conductive heat loss but not air infiltration (storm windows would reduce both) and therefore would not be cost-effective.

The Question of Ceiling Insulation. The crawl spaces in all Cambridge buildings are already insulated with 7 inches of fiberglass insulation, providing an R-value of R-25. While there is sufficient space to add more insulation to these crawl spaces, the auditor determined that it would not be cost-effective to do so.

Insulating Steam Lines. None of Cambridge's steam lines are insulated. Since much of the piping runs through unheated basement areas, 1 inch of fiberglass insulation was recommended wherever feasible.

The Question of Electric Ignition. Two of Cambridge's boilers are currently equipped with electric ignitions, while the others use standard pilot lights that remain lit at all times. The boiler manufacturer has indicated that retrofit units are available to convert the gas pilots to electrically ignited units. The cost of doing so, however, would be high enough to make such conversion only marginally cost-effective. The auditor therefore recommended that other measures definitely be assigned a higher priority.

Installing Separate Hot-Water Heaters. At present, all domestic hot water used in the Cambridge buildings is produced by a boiler heat exchanger. The energy auditor pointed out that this method of hot-water production is inefficient because there is "double handling" of energy to heat the water. Furthermore, the boiler must continue to remain active during the nonheating season solely for the purpose of producing the steam utilized in the heat exchanger. Separate heaters to meet domestic hot-water demand could produce considerable savings. Such heaters should be sized to accommodate tenants' needs and should provide large, well-insulated storage tanks.

All of these findings are recorded in the following forms (see Figures 2 and 3).

Cost-effectiveness Calculations
The auditor's conclusions and recommendations were based in part on various cost-effectiveness calculations (see Chapter 2). These calculations are summarized in the chart that follows.

It is important to remember that the loan rate is a key factor in determining cost-effectiveness. A higher interest rate than the one used in these figures would decrease the net-present-value sums, while a lower rate would increase them. This is only logical, since the more expensive a measure becomes, the more return there must be to make it cost-effective.

Figure 2 COST AND SAVINGS INFORMATION FORM				
DESCRIPTION OF ENERGY-SAVING MEASURE	**Estimated Year's Saving (from Appendix)**	**Useful Life of Energy-Saving Improvement**	**Estimated Initial Cost**	**Annual Maintenance Cost**
Caulking and sealants in building joints	$ 4,043	5	$10,400	$ 0
Weatherstripping doors and windows	2,737	15	15,486	0
Installation of individual utility meters or checkmeters (for electricity and for natural gas)	N/A	N/A	N/A	N/A
Ceiling insulation	325	20	13,000	0
Insulation of hot-water heating and steam pipes	6,162	20	6,050	0
Insulation of heating and cooling ducts in unheated spaces	N/A	N/A	N/A	N/A
Clock thermostats for units with individual heating units	N/A	N/A	N/A	N/A
Storm windows or replacement of single-glazed with double-glazed windows	9,745	12	51,920	700
Flow restrictors for hot-water lines to showerheads or faucets	12,790	5	4,265	0
Thermostatic radiator valves	11,734	15	58,900	1,000
Replacement of incandescent fixtures in public spaces with higher-efficiency lighting	N/A	N/A	N/A	N/A
Exterior insulation for water heaters located in unheated spaces	N/A	N/A	N/A	N/A
Improved burners, controls, capacitors, and other improvements for mechanical systems to lower fuel consumption or energy costs	272	20	2,205	0
Other Energy-Saving Opportunities (identified by the auditor) Install separate domestic hot-water heater	450	20	3,000	50

Length and Rate of Loan: 30 years @ 9.5%

Multiplier 2: .850

Figure 3 AUDIT CALCULATION WORKSHEET

Net Annual Savings (NAS)

Description of Energy-Saving Measure	Multiplier 1	Estimated First-Year Savings Minus Annual Maintenance Cost	Multiplier 1 × NAS = I	Multiplier 2 × Initial Cost = Y	X − Y = N (Net Present Value)
1. Install Storm Windows	9.82	9,745 − 700 = 9,045	9.82 × 9,045 = 88821.9	.850 × 51,920 = 44,132	88,821.9 − 44,132 = 44,689.90
2. Weatherstrip Windows	11.74	2,737 − 0 = 2,737	11.74 × 2,737 = 32132.38	.850 × 15,486 = 13,163.1	32,132.38 − 13,163.1 = 18,969.28
3. Caulking and Sealants	4.55	4,043 − 0 = 4,043	4.55 × 4,043 = 18395.65	.850 × 10,400 = 8,840	18,395.65 − 8,840 = 9,555.65
4. Add 4 in. to Existing Ceiling Insulation	14.56	325 − 0 = 325	14.56 × 325 = 4732	.850 × 13,000 = 11,050	4,372 − 11,050 = 6,318.00
5. Insulate Steam Pipes	14.56	6,162 − 0 = 6,162	14.56 × 6,162 = 89718.72	.850 × 6,050 = 5,142.5	89,718.72 − 5,142.5 = 84,576.22
6. Install Thermostatic Air Vents	11.74	11,734 − 1,000 = 10,734	11.74 × 10,734 = 126017.16	.850 × 58,900 = 50,065	126,017.16 − 50,065 = 75,952.16
7. Install Flow Restrictors	4.55	12,790 − 0 = 12,790	4.55 × 12,790 = 58194.5	.850 × 4,265 = 3,625.25	58,194.5 − 3,625.25 = 54,569.25
8. Install Separate Water Heater	14.56	450 − 50 = 400	14.56 × 400 = 5824	.850 × 3,000 = 2,550	5,824 − 2,550 = 3,274.00
9. Install Electric Ignition	14.56	272 − 0 = 272	14.56 × 272 = 3960.32	.850 × 2,205 = 1,874.25	3,960.32 − 1,874.25 = 2,086.07

SUMMARY CHART
Cambridge House Apartments

Energy-Saving Measure	Initial Cost	Estimated First-Year Savings	Annual Maintenance Costs	Net Annual Savings	Modification Lifetime	Net Present Value
Install Storm Windows	$51,920	$9,745	$700	$9,045	15	$44,690
Weatherstrip Windows	15,486	2,737	0	2,737	15	18,969
Apply Caulking and Sealants	10,400	4,043	0	4,043	5	9,556
Add 4 in. to existing ceiling insulation	13,000	325	0	325	20	6,318
Insulate Steam Pipes	6,050	6,162	0	6,162	20	84,576
Install Thermostatic Air Vents	58,900	11,734	1,000	10,734	15	75,952
Install Flow Restrictors	4,265	12,790	0	12,790	5	54,569
Install Separate Water Heater	3,000	450	50	400	20	3,274
Install Electric Ignition	2,205	272	0	272	20	2,086

CHAPTER 5

Implementating the Energy Standards Through HUD Rehabilitation Programs

An important aspect of the rehabilitation trend is the new awareness of the need for energy conservation—a need that stems not just from political factors, but from economic realities as well. As one rehabilitation specialist summed it up:

> If I had been rehabilitating buildings years ago, I probably wouldn't have worried about insulation and all the rest of it. Everything was cheap and plentiful. Today, though, cutting corners on conservation is just penny wise and pound foolish. A poorly insulated building with an inefficient boiler can turn a rehabilitated building into a financial disaster. Nowadays when you're rehabilitating a building, it's just plain silly not to do what you can to make that building energy-efficient . . . .

Government officials and rehabilitation program administrators agree. Energy conservation measures—as prescribed by the Energy Standards—are now part of community development efforts in such HUD programs as:

- Section 312 Rehabilitation Loan program
- Community Development Block Grant (CDBG) program—on units being counted toward HAP goals
- Section 203(k) Home Mortgage Insurance program
- Section 8 Substantial Rehabilitation program
- Flexible Subsidy program

GENERAL PROGRAM PROCEDURES

Precisely how the Energy Standards affect each of the programs mentioned above varies somewhat from one program to the next. However, all programs require certain basic steps to determine whether the proposed rehabilitation will make the installation or application of a particular energy-saving improvement possible and whether the improvement will be cost-effective. These steps include the following:

1. An inspection to identify the areas of a building in need of rehabilitation. Depending on the program, this inspection may be conducted by the owner or developer, a program official, or some other designated individual.
2. An energy review or an energy audit (described in previous chapters) to identify necessary energy-saving improvements.

3. The determination—made by a program official—of whether project funds will accommodate all or some of the recommended energy-saving improvements.

Financing

Information on financing HUD rehabilitation work is available from HUD Area Offices and from many private lenders. Other sources of information include the following HUD publications.

Examples of Local and State Financing of Property Rehabilitation. Community Planning and Development Program Guide No. 1, August 1974.
Financial Leveraging in Community Development Rehabilitation, July 1979.
Financing Multifamily Rehabilitation, January 1979. (This guide is concerned chiefly with the Section 8 NSA program.)
Home Improvement Financing, April 1979.
Neighborhood Conservation and Property Rehabilitation Bibliography, November 1979.

At one time, the interest rates and loan terms that HUD authorized for rehabilitation work were somewhat restrictive. Currently, however, HUD authorizes a wide variety of financing methods. Because each program has different criteria, it is essential that interested parties become familiar with individual program requirements, so that they can develop a practical and realistic financing plan.

SPECIFIC PROGRAM PROCEDURES

The sections that follow provide a brief overview of the HUD rehabilitation programs in which the Energy Standards are required, including how they are to be implemented in each program. Note that this discussion is intended to highlight the incorporation of the Energy Standards rather than to explain in detail every step of each application process. For comprehensive information about each program, consult the official handbook for that program. Interested applicants can obtain the latest information about each program by contacting the nearest HUD Area Office, which is listed in Appendix F.

Section 312 Rehabilitation Loan Program

The Section 312 Rehabilitation Loan program enables multifamily property owners and property owners in designated urban homesteading areas to receive direct federal loans to rehabilitate their properties. A fundamental goal of the 312 program is to provide financial assistance for the rehabilitation of damaged or deteriorated property in neighborhood revitalization areas. Loans are used primarily for repairs and improvements that will bring property into compliance with local housing and building codes. In addition, a portion of a loan may be used to pay for general property improvements, including energy-saving improvements.

During Fiscal Year 1982, the Section 312 Rehabilitation Loan Program was funded through loan repayments. It was also redirected and targeted to multifamily and urban homesteading properties.

Community Development Block Grant Program

The Community Development Block Grant (CDBG) program awards block grants to local governments to help them carry out community development activities. More than 2,500 local governments use CDBG funds in property rehabilitation programs. Individual property owners usually receive financial assistance in the form of direct grants and loans or as private loan subsidies or guarantees.

New rules apply the Energy Standards to certain rehabilitation activities* funded by the CDBG program, including the rehabilitation of dwelling units that are counted as part of the goals of a Housing Assistance Plan (HAP) and rehabilitation in which Block Grant funds are used to *acquire* properties for rehabilitation.

The rules are intended to benefit lower-income individuals who suffer the most from rising fuel costs, and also to help local areas improve the energy efficiency of rehabilitated housing in general.

Properties to which these rules may apply include permanent housing units, both single-family and multifamily, for sale or rent; and residential facilities, such as group homes, halfway houses, and emergency shelters.

To determine whether rehabilitation loans or grants are available for a particular locality, the property owner should contact the local office administering the CDBG program, which is usually either the Department of Community Development or the Housing Rehabilitation Office.

Section 203(k) Home Mortgage Insurance Program

The 203(k) Home Mortgage Insurance program seeks to encourage the rehabilitation and preservation of single-family homes and other one-to-four unit buildings. A 203(k) mortgage loan is not a HUD loan, but rather a loan made by a band, a building-and-loan association, a mortgage company or another HUD-approved mortgagee that is insured by HUD.

Loans may be used to rehabilitate a currently owned dwelling; purchase and then rehabilitate a dwelling; or refinance existing indebtedness and rehabilitate a dwelling. A wide range of rehabilitation activities are eligible under the 203(k) program, including various cost-effective energy conservation measures.

Projects are funded either before or after rehabilitation work takes place, depending on whether the 203(k) mortgage involves the insurance of advances. Advances to cover rehabilitation costs may be provided to the homeowner

*These activities are subject to Section 8 Existing Housing Quality Standards.

while work is going on and directly after its completion. Mortgages that do not involve insured advances are endorsed only after all rehabilitation work has been satisfactorily completed, and no funds are made available until that time.

Interested applicants should contact their local HUD Area Office to obtain a list of local lenders that have been approved by HUD to make 203(k) mortgage loans.

Flexible Subsidy Program

The Flexible Subsidy program provides federal financial assistance to the owners of troubled multifamily housing projects. The program is a grant/loan program. HUD Field Offices award funds according to the needs of individual projects.

The Flexible Subsidy program is concerned with the repair and maintenance of housing projects for low- and moderate-income residents. The program allows an owner to make repairs and physical improvements, including energy conservation measures, and also provides funds to help reduce a project's operating deficit.

The program is not intended to be the sole source of assistance for housing projects. Its purpose is to supplement other funding methods, such as Section 8 assistance, mortgage modifications, and rental increases.

Housing projects receiving assistance under the Section 221(d) (3) or Section 236 programs or receiving rent-supplement payments are eligible to participate in the Flexible Subsidy program.

APPENDIX A Loan Program Table

MULTIPLIER 2

Interest Rate	LIFE OF LOAN IN YEARS 1	2	3	4	5	6	7	8	9	10	11	12	13
3.00	.960	.922	.886	.852	.820	.791	.763	.737	.712	.689	.667	.647	.628
3.50	.963	.927	.893	.861	.831	.802	.776	.751	.728	.706	.685	.665	.647
4.00	.966	.931	.899	.869	.841	.814	.789	.765	.743	.722	.703	.684	.667
4.50	.968	.936	.906	.878	.851	.826	.802	.780	.759	.739	.721	.703	.687
5.00	.971	.941	.913	.886	.862	.838	.816	.795	.775	.757	.739	.723	.707
5.50	.973	.946	.920	.895	.872	.850	.830	.810	.792	.774	.758	.743	.728
6.00	.976	.951	.927	.904	.883	.862	.843	.825	.808	.792	.777	.763	.749
6.50	.979	.955	.934	.913	.893	.875	.857	.841	.825	.810	.796	.783	.770
7.00	.981	.960	.941	.922	.904	.887	.871	.856	.842	.828	.816	.804	.792
7.50	.984	.965	.947	.931	.915	.900	.885	.872	.859	.847	.835	.825	.814
8.00	.986	.970	.955	.940	.926	.912	.900	.888	.876	.866	.855	.846	.837
8.50	.989	.975	.962	.949	.937	.925	.914	.904	.894	.885	.876	.867	.859
9.00	.992	.980	.969	.958	.948	.938	.929	.920	.912	.904	.896	.889	.883
9.50	.994	.985	.976	.967	.959	.951	.943	.936	.930	.923	.917	.911	.906
10.00	.997	.990	.983	.976	.970	.964	.958	.953	.948	.943	.938	.934	.930
11.00	1.002	1.000	.997	.995	.993	.990	.988	.986	.984	.983	.981	.979	.978
11.50	1.005	1.005	1.004	1.004	1.004	1.004	1.004	1.003	1.003	1.003	1.003	1.003	1.003
12.00	1.008	1.010	1.012	1.014	1.015	1.017	1.019	1.021	1.022	1.023	1.025	1.026	1.027
13.00	1.013	1.020	1.026	1.033	1.039	1.044	1.050	1.055	1.060	1.065	1.070	1.074	1.078
14.00	1.018	1.030	1.041	1.052	1.062	1.072	1.082	.1.091	1.099	1.108	1.115	1.123	1.130
15.00	1.024	1.040	1.056	1.071	1.086	1.100	1.114	1.127	1.139	1.151	1.162	1.173	1.183
16.00	1.029	1.050	1.071	1.091	1.110	1.129	1.146	1.163	1.180	1.195	1.210	1.223	1.236
17.00	1.034	1.060	1.086	1.111	1.134	1.157	1.179	1.201	1.221	1.240	1.258	1.275	1.291
18.00	1.040	1.071	1.101	1.131	1.159	1.187	1.213	1.238	1.262	1.285	1.307	1.327	1.347
19.00	1.045	1.081	1.116	1.151	1.184	1.216	1.247	1.277	1.305	1.332	1.357	1.381	1.403
20.00	1.050	1.092	1.132	1.171	1.209	1.246	1.282	1.316	1.348	1.378	1.407	1.435	1.460

MULTIPLIER 1
(FOR USE WITH MULTIFAMILY ONLY)

Savings Multiplier	**.97**	**1.91**	**2.82.**	**3.70**	**4.55**	**5.38**	**6.18**	**6.95**	**7.70**	**8.43**	**9.14**	**9.82**	**10.48**

APPENDIX A Loan Program Table

MULTIPLIER 2

Interest Rate	LIFE OF LOAN IN YEARS 14	15	16	17	18	19	20	21	22	23	24	25	26
3.00	.610	.593	.577	.562	.547	.534	.521	.509	.498	.487	.477	.467	.458
3.50	.630	.614	.598	.584	.570	.557	.545	.533	.523	.512	.503	.493	.485
4.00	.650	.635	.620	.606	.593	.581	.569	.558	.548	.538	.529	.520	.512
4.50	.671	.657	.643	.630	.617	.605	.594	.584	.574	.565	.556	.548	.540
5.00	.692	.679	.666	.653	.642	.630	.620	.610	.601	.592	.584	.576	.569
5.50	.714	.701	.689	.677	.666	.656	.646	.637	.628	.620	.612	.605	.598
6.00	.736	.724	.713	.702	.692	.682	.673	.665	.656	.649	.642	.635	.628
6.50	.759	.747	.737	.727	.718	.709	.700	.693	.685	.678	.672	.665	.659
7.00	.781	.771	.762	.753	.744	.736	.728	.721	.714	.708	.702	.696	.691
7.50	.805	.795	.787	.779	.771	.764	.757	.750	.744	.739	.733	.728	.723
8.00	.828	.820	.812	.805	.798	.792	.786	.780	.775	.770	.765	.760	.756
8.50	.852	.845	.838	.832	.826	.820	.815	.810	.806	.801	.797	.793	.790
9.00	.876	.870	.865	.859	.854	.850	.845	.841	.837	.833	.830	.827	.824
9.50	.901	.896	.891	.887	.883	.879	.876	.872	.869	.866	.863	.861	.858
10.00	.926	.922	.919	.915	.912	.909	.906	.904	.902	.899	.897	.895	.893
11.00	.977	.975	.974	.973	.972	.971	.970	.969	.968	.967	.966	.966	.965
11.50	1.002	1.002	1.002	1.002	1.002	1.002	1.002	1.002	1.002	1.001	1.001	1.001	1.001
12.00	1.029	1.030	1.031	1.032	1.033	1.033	1.034	1.035	1.036	1.036	1.037	1.037	1.038
13.00	1.032	1.085	1.089	1.092	1.095	1.098	1.100	1.103	1.105	1.107	1.109	1.111	1.113
14.00	1.136	1.143	1.148	1.154	1.159	1.164	1.168	1.172	1.176	1.179	1.183	1.186	1.189
15.00	1.192	1.201	1.209	1.217	1.224	1.231	1.237	1.243	1.248	1.253	1.257	1.262	1.265
16.00	1.248	1.260	1.271	1.281	1.290	1.299	1.307	1.314	1.321	1.327	1.333	1.338	1.343
17.00	1.365	1.320	1.333	1.346	1.357	1.368	1.378	1.387	1.395	1.403	1.410	1.416	1.422
18.00	1.306	1.381	1.397	1.412	1.425	1.438	1.449	1.460	1.470	1.479	1.487	1.495	1.501
19.00	1.424	1.444	1.462	1.479	1.494	1.509	1.522	1.534	1.545	1.556	1.565	1.574	1.581
20.00	1.484	1.507	1.527	1.546	1.564	1.580	1.595	1.609	1.622	1.633	1.644	1.653	1.662

MULTIPLIER 1
(FOR USE WITH MULTIFAMILY ONLY)

Savings Multiplier	11.12	11.74	12.34	12.92	13.48	14.03	14.56	15.07	15.56	16.04	16.51	16.96	17.40

APPENDIX A Loan Program Table

MULTIPLIER 2

Interest Rate	LIFE OF LOAN IN YEARS 27	28	29	30	31	32	33	34	35	36	37	38	39	40
3.00	.450	.442	.434	.426	.419	.413	.407	.401	.395	.389	.384	.379	.375	.370
3.50	.476	.469	.461	.454	.448	.441	.435	.429	.424	.419	.414	.409	.405	.401
4.00	.504	.497	.490	.483	.477	.471	.465	.459	.454	.449	.445	.440	.436	.432
4.50	.532	.525	.519	.512	.506	.501	.495	.490	.486	.481	.477	.472	.469	.465
5.00	.562	.555	.549	.543	.537	.532	.527	.522	.518	.513	.509	.506	.502	.499
5.50	.592	.586	.580	.574	.569	.564	.559	.555	.551	.547	.543	.540	.536	.533
6.00	.622	.617	.611	.606	.601	.597	.593	.589	.585	.581	.578	.575	.572	.569
6.50	.654	.649	.644	.639	.635	.631	.627	.623	.620	.616	.613	.611	.608	.605
7.00	.686	.681	.677	.673	.669	.665	.662	.658	.655	.652	.650	.647	.645	.642
7.50	.719	.715	.711	.707	.703	.700	.697	.694	.691	.689	.687	.684	.682	.680
8.00	.752	.749	.745	.742	.739	.736	.733	.731	.728	.726	.724	.722	.720	.719
8.50	.786	.783	.780	.777	.775	.772	.770	.768	.766	.764	.762	.761	.759	.758
9.00	.821	.818	.816	.813	.811	.809	.807	.806	.804	.802	.801	.800	.798	.797
9.50	.856	.854	.852	.850	.848	.847	.845	.844	.843	.841	.840	.839	.838	.837
10.00	.892	.890	.889	.887	.886	.885	.884	.882	.882	.881	.880	.879	.878	.878
11.00	.964	.964	.963	.963	.962	.962	.961	.961	.961	.960	.960	.960	.960	.959
11.50	1.001	1.001	1.001	1.001	1.001	1.001	1.001	1.001	1.001	1.001	1.001	1.001	1.001	1.001
12.00	1.039	1.039	1.039	1.040	1.040	1.040	1.041	1.041	1.041	1.042	1.042	1.042	1.042	1.042
13.00	1.114	1.116	1.117	1.118	1.119	1.120	1.121	1.122	1.123	1.124	1.124	1.125	1.125	1.126
14.00	1.191	1.193	1.196	1.198	1.199	1.201	1.203	1.204	1.205	1.207	1.208	1.209	1.209	1.210
15.00	1.269	1.272	1.275	1.278	1.281	1.283	1.285	1.287	1.289	1.290	1.292	1.293	1.294	1.295
16.00	1.348	1.352	1.356	1.359	1.362	1.365	1.368	1.370	1.372	1.374	1.376	1.377	1.379	1.380
17.00	1.427	1.432	1.437	1.441	1.445	1.448	1.451	1.454	1.456	1.459	1.461	1.462	1.464	1.466
18.00	1.508	1.513	1.518	1.523	1.527	1.531	1.535	1.538	1.541	1.543	1.546	1.548	1.550	1.551
19.00	1.588	1.595	1.601	1.606	1.611	1.615	1.619	1.622	1.625	1.628	1.631	1.633	1.635	1.637
20.00	1.670	1.677	1.683	1.689	1.694	1.699	1.703	1.707	1.710	1.713	1.716	1.719	1.721	1.723

MULTIPLIER 1
(FOR USE WITH MULTIFAMILY ONLY)

Savings Multiplier	**17.82**	**18.23**	**18.63**	**19.01**	**19.38**	**19.74**	**20.09**	**20.43**	**20.76**	**21.07**	**21.38**	**21.68**	**21.97**	**22.25**

APPENDIX B
Heating Degree Days Table

Average Yearly Degree Days for Cities in the United States (Base 65° F)

(Extracted by permission from 1976 ASHRAE Systems Handbook published by the American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc., Atlanta, Ga.)

State	Station*		Avg. Winter Temperature°	Yearly Total
Ala.	Birmingham	A	54.2	2551
	Huntsville	A	51.3	3070
	Mobile	A	59.9	1560
	Montgomery	A	55.4	2291
Alaska	Anchorage	A	23.0	10864
	Fairbanks	A	6.7	14279
	Juneau	A	32.1	9075
	Nome	A	13.1	14171
Ariz.	Flagstaff	A	35.6	7152
	Phoenix	A	58.5	1765
	Tucson	A	58.1	1800
	Winslow	A	43.0	4782
	Yuma	A	64.2	974
Ark.	Fort Smith	A	50.3	3292
	Little Rock	A	50.5	3219
	Texarkana	A	54.2	2533
Calif.	Bakersfield	A	55.4	2122
	Bishop	A	46.0	4275
	Blue Canyon	A	42.2	5596
	Burbank	C	58.6	1646
	Eureka	A	49.9	4643
	Fresno	A	53.3	2611
	Long Beach	A	57.8	1803
	Los Angeles	C	57.4	2061
	Los Angeles	C	60.3	1349
	Mt. Shasta	A	41.2	5722
	Oakland	A	53.5	2870
	Red Bluff	A	53.8	2515
	Sacramento	C	53.9	2502
	Sacramento	C	54.4	2419
	Sandberg	A	46.8	4209
	San Diego	A	59.5	1458
	San Francisco	C	53.4	3015
	San Francisco	A	55.1	3001
	Santa Maria	A	54.3	2967
Colo.	Alamosa	A	29.7	8529
	Colorado Springs	A	37.3	6423
	Denver	C	37.6	6283
	Denver	A	40.8	5524
	Grand Junction	A	39.3	5641
	Pueblo	A	40.4	5462
Conn.	Bridgeport	A	39.9	5617
	Hartford	A	37.3	6235
	New Haven	A	39.0	5897
Del.	Wilmington	A	42.5	4930
D.C.	Washington	C	45.7	4224
Fla.	Apalachicola	A	61.2	1308
	Daytona Beach	A	64.5	879
	Fort Myers	A	68.6	442
	Jacksonville	A	61.9	1239
	Key West	C	73.1	108
	Lakeland	A	66.7	661
	Miami	A	71.1	214

*Data for airport stations, A, and city stations, C, are both given where available.

State	Station*		Avg. Winter Temperature°	Yearly Total
	Miami Beach	C	72.5	141
	Orlando	A	65.7	766
	Pensacola	A	60.4	1463
	Tallahassee	A	60.1	1485
	Tampa	A	66.4	683
	West Palm Beach	A	68.4	253
Ga.	Athens	A	51.8	2929
	Atlanta	A	51.7	2961
	Augusta	A	54.5	2397
	Columbus	A	54.8	2383
	Macon	A	56.2	2136
	Rome	A	49.9	3326
	Savannah	A	57.8	1819
	Thomasville	C	60.0	1529
Hawaii	Lihue	A	72.7	0
	Honolulu	A	74.2	0
	Hilo	A	71.9	0
Idaho	Boise	A	39.7	5809
	Lewiston	A	41.0	5542
	Pocatello	A	34.8	7033
Ill.	Cairo	C	47.9	3821
	Chicago (O'Hare)	A	35.8	6639
	Chicago (Midway)	A	37.5	6155
	Chicago	C	38.9	5882
	Moline	A	36.4	6408
	Peoria	A	38.1	6025
	Rockford	A	34.8	6830
	Springfield	A	40.6	5429
Ind.	Evansville	A	45.0	4435
	Fort Wayne	A	37.3	6205
	Indianapolis	A	39.6	5699
	South Bend	A	36.6	6439
Iowa	Burlington	A	37.6	6114
	Des Moines	A	35.5	6588
	Dubuque	A	32.7	7376
	Sioux City	A	34.0	6951
	Waterloo	A	32.6	7320
Kans.	Concordia	A	40.4	5479
	Dodge City	A	42.5	4986
	Goodland	A	37.8	6141
	Topeka	A	41.7	5182
	Wichita	A	44.2	4620
Ky.	Covington	A	41.4	5265
	Lexington	A	43.8	4683
	Louisville	A	44.0	4660
La.	Alexandria	A	57.5	1921
	Baton Rouge	A	59.8	1560
	Lake Charles	A	60.5	1459
	New Orleans	A	61.0	1385
	New Orleans	C	61.8	1254
	Shreveport	A	56.2	2184
Me.	Caribou	A	24.4	9767
	Portland	A	33.0	7511
Md.	Baltimore	A	43.7	4654
	Baltimore	C	46.2	4111
	Frederich	A	42.0	5087
Mass.	Boston	A	40.0	5634
	Nantucket	A	40.2	5891
	Pittsfield	A	32.6	7578
	Worcester	A	34.7	6969
Mich.	Alpena	A	29.7	8506
	Detroit (City)	A	37.2	6232
	Detroit (Wayne)	A	37.1	6293
	Detroit (Willow Run)	A	37.2	6258
	Escanaba	C	29.6	8481
	Flint	A	33.1	7377
	Grand Rapids	A	34.9	6894

State	Station*		Avg. Winter Temperature°	Yearly Total
	Lansing	A	34.8	6909
		C	30.2	8393
	Marquette	A	36.0	6696
	Muskegon	A	27.7	9048
	Sault Ste. Marie			10000
		A	23.4	8382
Minn.	Duluth	A	28.3	8295
	Minneapolis	A	28.8	
	Rochester	A	55.7	2239
Miss.	Jackson	A	55.4	2289
	Meridian	C	56.9	2041
	Vicksburg			5046
		A	42.3	4711
Mo.	Columbia	A	43.9	5484
	Kansas City	A	40.3	4900
	St. Joseph	A	43.1	4484
	St. Louis	C	44.8	4900
	St. Louis	A	44.5	
	Springfield			7049
		A	34.5	8996
Mont.	Billings	A	26.4	7750
	Glasgow	A	32.8	8700
	Great Falls	A	28.1	8182
	Havre	C	29.8	
	Havre			8129
		A	31.1	8191
	Helena	A	31.4	7723
	Kalispell	A	31.2	8125
	Miles City	A	31.5	
	Missoula			6530
		A	36.0	5864
Neb.	Grand Island	C	38.8	6979
	Lincoln	A	34.0	6684
	Norfolk	A	35.5	6612
	North Platte	A	35.6	6673
	Omaha	A	35.9	7425
	Scottsbluff	A	32.6	
	Valentine			7433
		A	34.0	7733
Nev.	Elko	A	33.1	2709
	Ely	A	53.5	6332
	Las Vegas	A	39.3	6761
	Reno	A	36.7	
	Winnemucca			7383
		A	33.0	13817
N.H.	Concord		15.2	
	Mt. Washington Obsv.			4812
		A	43.2	4589
N. J.	Atlantic City	A	42.8	4980
	Newark	C	42.4	
	Trenton			4348
		A	45.0	5158
N.M.	Albuquerque	A	42.0	6228
	Clayton	A	38.1	3793
	Raton	A	47.5	3705
	Roswell	A	48.0	
	Silver City			6875
		A	34.6	6201
N.Y.	Albany	C	37.2	7286
	Albany	A	33.9	6451
	Binghamton	C	36.6	
	Binghamton			7062
		A	34.5	4871
	Buffalo	C	42.8	4811
	New York (Cent. Park)	A	43.1	5219
	New York (LaGuardia)	A	41.4	6748
	New York (Kennedy)	A	35.4	6650
	Rochester	C	35.4	6756
	Schenectady	A	35.2	
	Syracuse	C	46.7	4042
			53.3	2612
N.C.	Asheville		50.4	3191
	Cape Hatteras	A	47.5	3805
	Charlotte	A	49.4	3393
	Greensboro	A	54.6	2347
	Raleigh	A	48.4	3595
	Wilmington	A		
	Winston-Salem		26.6	8851
		A	22.4	9901
N.D.	Bismarck	C		
	Devils Lake			

State	Station*		Avg. Winter Temperature°	Yearly Total
	Fargo	A	24.8	9226
	Williston	A	25.2	9243
Ohio	Akron–Canton	A	38.1	6037
	Cincinnati	C	45.1	4410
	Cleveland	A	37.2	6351
	Columbus	A	39.7	5660
	Columbus	C	41.5	5211
	Dayton	A	39.8	5622
	Mansfield	A	36.9	6403
	Sandusky	C	39.1	5796
	Toledo	A	36.4	6494
	Youngstown	A	36.8	6417
Okla.	Oklahoma City	A	48.3	3725
	Tulsa	A	47.7	3860
Ore.	Astoria	A	45.6	5186
	Burns	C	35.9	6957
	Eugene	A	45.6	4726
	Meacham	A	34.2	7874
	Medford	A	43.2	5008
	Pendleton	A	42.6	5127
	Portland	A	45.6	4635
	Portland	C	47.4	4109
	Roseburg	A	46.3	4491
	Salem	A	45.4	4754
Pa.	Allentown	A	38.9	5810
	Erie	A	36.8	6451
	Harrisburg	A	41.2	5251
	Philadelphia	A	41.8	5144
	Philadelphia	C	44.5	4486
	Pittsburgh	A	38.4	5987
	Pittsburgh	C	42.2	5053
	Reading	C	42.4	4945
	Scranton	A	37.2	6254
	Williamsport	A	38.5	5934
R.I.	Block Island	A	40.1	5804
	Providence	A	38.8	5954
S.C.	Charleston	A	56.4	2033
	Charleston	C	57.9	1794
	Columbia	A	54.0	2484
	Florence	A	54.5	2387
	Greenville–Spartenburg	A	51.6	2980
S.D.	Huron	A	28.8	8223
	Rapid City	A	33.4	7345
	Sioux Falls	A	30.6	7839
Tenn.	Bristol	A	46.2	4143
	Chattanooga	A	50.3	3254
	Knoxville	A	49.2	3494
	Memphis	A	50.5	3232
	Memphis	C	51.6	3015
	Nashville	A	48.9	3578
	Oak Ridge	C	47.7	3817
Tex.	Abilene	A	53.9	2624
	Amarillo	A	47.0	3985
	Austin	A	59.1	1711
	Brownsville	A	67.7	600
	Corpus Christi	A	64.6	914
	Dallas	A	55.3	2363
	El Paso	A	52.9	2700
	Fort Worth	A	55.1	2405
	Galveston	A	62.2	1274
	Galveston	C	62.0	1235
	Houston	A	61.0	1396
	Houston	C	62.0	1278
	Laredo	A	66.0	797
	Lubbock	A	48.8	3578
	Midland	A	53.8	2591
	Port Arthur	A	60.5	1447
	San Angelo	A	56.0	2255

State	Station*		Avg. Winter Temperature°	Yearly Total
	San Antonio	A	60.1	1546
	Victoria	A	62.7	1173
	Waco	A	57.2	2030
	Wichita Falls	A	53.0	2832
Utah	Milford	A	36.5	6497
	Salt Lake City	A	38.4	6052
	Wendover	A	39.1	5778
Va.	Cape Henry	C	50.0	3279
	Lynchburg	A	46.0	4166
	Norfolk	A	49.2	3421
	Richmond	A	47.3	3865
	Roanoke	A	46.1	4150
Vt.	Burlington	A	29.4	8269
Wash.	Olympia	A	44.2	5236
	Seattle–Tacoma	A	44.2	5145
	Seattle	C	46.9	4424
	Spokane	A	36.5	6655
	Walla Walla	C	43.8	4805
	Yakima	A	39.1	5941
W. Va.	Charleston	A	44.8	4476
	Elkins	A	40.1	5675
	Huntington	A	45.0	4446
	Parkersburg	C	43.5	4754
Wisc.	Green Bay	A	30.3	8029
	La Crosse	A	31.5	7589
	Madison	A	30.9	7863
	Milwaukee	A	32.6	7635
Wyo.	Casper	A	33.4	7410
	Cheyenne	A	34.2	7381
	Lander	A	31.4	7870
	Sheridan	A	32.5	7680

APPENDIX C
Cooling Hours Table*

Based on estimated equivalent rated full-load hours of operation for properly sized equipment during normal cooling season (Reprinted by permission from 1976 ASHRAE Systems Handbook).)

Albuquerque, NM	800–2200	Indianapolis, IN	600–1600
Atlantic City, NJ	500–800	Little Rock, AR	1400–2400
Birmingham, AL	1200–2200	Minneapolis, MN	400–800
Boston, MA	400–1200	New Orleans, LA	1400–2800
Burlington, VT	200–600	New York, NY	500–1000
Charlotte, NC	700–1100	Newark, NJ	400–900
Chicago, IL	500–1000	Oklahoma City, OK	1100–2000
Cleveland, OH	400–800	Pittsburgh, PA	900–1200
Cincinnati, OH	1000–1500	Rapid City, SD	800–1000
Columbia, SC	1200–1400	St. Joseph, MO	1000–1600
Corpus Christi, TX	2000–2500	St. Petersburg, FL	1500–2700
Dallas, TX	1200–1600	San Diego, CA	800–1700
Denver, CO	400–800	Savannah, GA	1200–1400
Des Moines, IA	600–1000	Seattle, WA	400–1200
Detroit, MI	700–1000	Syracuse, NY	200–1000
Duluth, MN	300–500	Trenton, NJ	800–1000
El Paso, TX	1000–1400	Tulsa, OK	1500–2200
Honolulu, HI	1500–3500	Washington, DC	700–1200

*To use this table, locate the city of the rehabilitation project or the city closest to it. Add the numbers shown and divide by two. This will provide an average figure for the area.

APPENDIX D
Estimating First-Year Savings for Multifamily Buildings

To calculate seasonal dollar savings from adding insulation, use the step-by-step worksheet below. An example of how to fill in the worksheet follows on page 42.

1.	Fill in the R–value of insulation being added	____ : R_i
2.	Compute the R–value of existing wall or other building component (Note: To do this, obtain the necessary R–values from Table A on page 44. For an air space of .5 inches or more, assume an R–value of 1.00 (See the example on page 42)	____ : R_e
3.	Add: $R_i + R_e =$	____ : R_n
4.	Calculate the reciprocal U–value of R_e: $U = 1 \div R_e =$	____ : U_e
5.	Calculate the reciprocal U–value of R_n: $U = 1 \div R_n =$	____ : U_n
6.	Subtract: $U_e - U_n$ to get the change in U–value =	____ : ΔU
7.	Fill in the number of net square feet in the wall (gross wall less window and door area) or other building component	____ : sq. ft.
8.	Multiply: line 6 × line 7 =	____
9.	Multiply line 8 by one of the following— Old furnace: 48 New furnace: 37 Electric heat: 24 (Note: these numbers adjust for furnace efficiency and 24-hour time factor.) Multiply line 8 × ____ =	____
10.	Fill in the number of seasonal heating degree days in your area (see Appendix A)	____
11.	Multiply: line 10 × line 9 =	____
12.	Fill in "factor C_D" from Table B on page 46	____
13.	Multiply: line 12 × line 11 =	____ : BTUs saved per season
14.	Fill in the BTU rating of the fuel (see Table C on page 46)	____
15.	Divide line 13 by line 14 =	____ : amount of fuel saved
16.	Fill in the unit price of fuel in your area (Obtain this number from your local dealer)	$____
17.	Multiply: line 16 × line 15 =	$____ : seasonal savings

This product represents your total seasonal savings from adding insulation to the wall or building component in question.

EXAMPLE

Notes:

(a) For the purpose of this example, refer to the wall shown in Figure 1 on page 43. Also, assume the following construction data:
⅜" wood clapboards

¾" plywood sheathing
3½" air space
½" sheet rock

(b) The building is located in Boston, which has 6800 seasonal heating degree days.

(c) The improvement being made is the addition of 3½" of loose fill fiberglass insulation, with an R–value of 11, into the wall's air space.

(d) Assume #2 fuel oil at $1.20/gallon, and an old furnace.

Sample Calculation

1. $R_i = 11$
2. ⅜" wood clapboard: $3/8 \times 1.25 =$ .47
   ¾" plywood sheathing: $3/4 \times 1.25 =$ .94
   3½" air space: (assume R–value of 1.00) = 1.00
   ½" sheet rock = .45
   Add: 2.86
   $R_e = 2.86$
3. $R_n = 13.9 (R_i + R_e)$
4. $U_e = .35 (1 \div 2.86)$
5. $U_n = .07 (1 \div 13.9)$
6. $\Delta U = .28$
7. $8' \times 20' = 160$
   $3' \times 4' = 12$
   Subtract: $160 - 12 = 148$ sq. ft.
8. $.28 \times 148 = 41.1$
9. 41.4×48 (old furnace) = 1987
10. 6800 degree days
11. $6800 \times 1987 = 13{,}511{,}600$
12. .64
13. $.64 \times 13{,}511{,}600 = 8{,}647{,}424$
14. 140,000 BTU/gal
15. $8{,}647{,}424 \div 140{,}000 = 62$ gallons
16. $1.20
17. $74.40

Notes

A. To calculate savings from adding energy-conservation measures that retard infiltration (e.g., storm windows), the procedure is almost identical. The only difference is this:

Do *not* do steps 1–8. Instead, determine the size of the area or "crack" where infiltration occurs. A crack is an area around or through which air leakage is possible. In the case of a door, it would be the entire perimeter of the door. (A seven-foot by three-foot door has twenty feet of crackage: 7 + 3 + 7 + 3.) With a double-hung window made up of two two-foot-wide by three-foot-high panes, the crackage would be the entire outside perimeter (2 + 3 + 3 + 2 + 3 + 3) plus the crack between the two panes (2). Therefore, the total length of crackage would be 18 feet (see Figure 2). Multiply the total crackage by the appropriate "linear foot infiltration savings factor" shown in Table D on page 47. The resulting product corresponds to line 8 on the worksheet above. Steps 9–17 are then exactly the same.

B. Building owners should obtain professional help to determine possible savings linked to changes in mechanical systems.

C. Calculations for such inexpensive energy conservation measures as flow restrictors and faucet aerators have not been included here because these measures have generally been found to be cost-effective in most situations. (Note, however, that faucet aerators save money only in those situations where water runs continuously down a drain, as when washing your hands.) Building owners desiring such calculations should consult with an auditor.

Figure 1

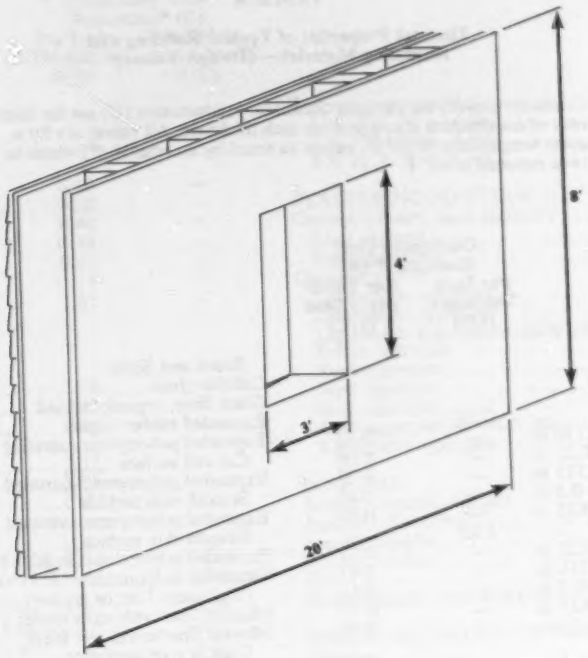


Figure 2

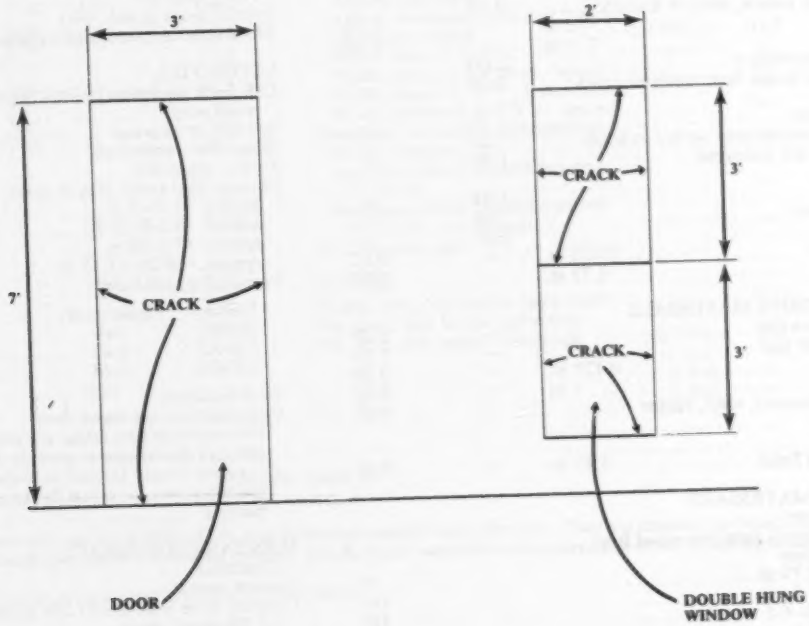


TABLE A

Thermal Properties of Typical Building and Insulating Materials—(Design Values)[a]

Conductivities (k) are per-inch thickness; conductances (C) are for thickness of construction stated, not per-inch thickness. All values are for a mean temperature of 75° F, except as noted by an asterisk (*) which have been reported at 45° F.

Description	Customary Unit Resistance[b] (R) Per Inch Thickness (1/k)	For Thickness Listed (1/C)
BUILDING BOARD		
Boards, Panels, Subflooring, Sheathing		
Woodboard Panel Products		
Asbestos—cement board	0.25	—
Asbestos—cement board 0.125 in.	—	0.03
Asbestos—cement board 0.25 in.	—	0.06
Gypsum or plaster board 0.375 in.	—	0.32
Gypsum or plaster board 0.5 in.	—	0.45
Gypsum or plaster board 0.625 in.	—	0.56
Plywood (Douglas Fir)	1.25	—
Plywood (Douglas Fir) 0.25 in.	—	0.31
Plywood (Douglas Fir) 0.375 in.	—	0.47
Plywood (Douglas Fir) 0.5 in.	—	0.62
Plywood (Douglas Fir) 0.625 in.	—	0.77
Plywood or wood panels 0.75 in.	—	0.93
Vegetable Fiber Board		
Sheathing, regular density 0.5 in.	—	1.32
0.78125 in.	—	2.06
Sheathing, intermediate density 0.5 in.	—	1.22
Nail-base sheathing 0.5 in.	—	1.14
Shingle backer 0.375 in.	—	0.94
Shingle backer 0.3125 in.	—	0.78
Sound deadening board 0.5 in.	—	1.35
Tile and lay-in panels, plain or acoustic	2.50	—
0.5 in.	—	1.25
0.75 in.	—	1.89
Laminated paperboard	2.00	—
Homogeneous board from repulped paper	2.00	—
Hardwood		
Medium density	1.37	—
High density, service temp. service underlay	1.22	—
High density, std. tempered	1.00	—
Particleboard		
Low density	1.85	—
Medium density	1.06	—
High density	0.85	—
Underlayment 0.625 in.	—	0.82
Wood subfloor 0.75 in.	—	0.94
FINISH FLOORING MATERIALS		
Carpet and fibrous pad	—	2.08
Carpet and rubber pad	—	1.23
Cork tile 0.125 in.	—	0.28
Terrazzo 1 in.	—	0.08
Tile—asphalt, linoleum, vinyl, rubber	—	0.05
vinyl asbestos		
ceramic		
Wood, hardwood finish 0.75 in.	—	0.68
INSULATING MATERIALS		
Blanket and Batt[c]		
Mineral Fiber, fibrous form processed from rock, slag, or glass		
approx. *2–2.75 in.	—	7[d]
approx. *3–3.5 in.	—	11[d]
approx. *5.50–6.5	—	19[d]
approx. *6–7 in.	—	22[d]
approx. [d]8.5 in.	—	30[d]
Board and Slabs		
Cellular glass	2.63	—
Glass fiber, organic bonded	4.00	—
Expanded rubber (rigid)	4.55	—
Expanded polystyrene extruded		
Cut cell surface	4.00	—
Expanded polystyrene extruded		
Smooth skin surface	5.00	—
Expanded polystyrene extruded		
Smooth skin surface	5.26	—
Expanded polystyrene, molded beads	3.57	—
Expanded polyurethane (R 11 exp.)	6.25	—
(Thickness 1 in. or greater)		
Mineral fiber with resin binder	3.45	—
Mineral fiberboard, wet felter		
Core or roof insulation	2.94	—
Acoustical tile	2.86	—
Acoustical tile	2.70	—
Mineral fiberboard, wet molded		
Acoustical tile	2.38	—
Wood or cane fiberboard		
Acoustical tile[f] 0.5 in.	—	1.25
Acoustical tile[f] 0.75 in.	—	1.89
Interior finish (plank, tile)	2.86	—
Wood shredded (cemented in preformed slabs)	1.67	—
LOOSE FILL		
Cellulosic insulation (milled paper or wood pulp)	3.13–3.70	—
Sawdust or shavings	2.22	—
Wood fiber, softwoods	3.33	—
Perlite, expanded	2.70	—
Mineral fiber (rock, slag or glass)		
approx. *3.75–5 in.		11
approx. *6.5–8.75 in.		19
approx. *7.5–10 in.		22
approx. *10.25–13.75 in.		30
Vermiculite, exfoliated		
Density (lb/ft³) / Conductivity (k)		
7.0–8.2 / 0.47	2.13	—
4.0–6.0 / 0.44	2.27	—
Roof Insulation		
Preformed, for use above deck		
Different roof insulations are available in different thicknesses to provide the design C values listed.[g] Consult individual manufacturers for actual thickness of their material	1.39 to 8.33	
MASONRY MATERIALS		
Concretes		
Cement mortar	0.20	—
Gypsum–fiber concrete 87.5% gypsum, 12.5% wood chips	0.60	—
Lightweight aggregates including expanded expanded shale, clay or slate; expanded		

TABLE A (continued)

	Customary Unit Resistance[b] (R) Per Inch Thickness (1/k)	For Thickness Listed (1/C)
slags, cinders; pumice; vermiculite; also cellular concretes		
Density (lb/ft³) / Conductivity (K)		
120 / 5.2	0.19	—
100 / 3.6	0.28	—
80 / 2.5	0.40	—
60 / 1.7	0.59	—
40 / 1.15	0.86	—
30 / 0.90	1.11	—
20 / 0.70	1.43	—
Perlite, expanded		
Density (lb/ft³) / Conductivity (K)		
40 / 0.93	1.08	—
30 / 0.71	1.41	—
20 / 0.50	2.00	—
Sand and gravel or stone aggregate (oven dried)	0.11	
Sand and gravel or stone aggregate (not dried)	0.08	
Stucco	0.20	
MASONRY		
Brick, common[h]	0.20	—
Brick, face[h]	0.11	—
Clay tile, hollow:		
1 cell deep — 3 in.	—	0.80
1 cell deep — 4 in.	—	1.11
2 cells deep — 6 in.	—	1.52
2 cells deep — 8 in.	—	1.85
2 cells deep — 10 in.	—	2.22
3 cells deep — 12 in.	—	2.50
Concrete blocks, three oval core:		
Sand and gravel aggregate — 4 in.	—	0.71
8 in.	—	1.11
12 in.	—	1.28
Cinder aggregate — 3 in.	—	0.86
4 in.	—	1.11
8 in.	—	1.72
12 in.	—	1.89
Lightweight aggregate — 3 in.	—	1.27
(expanded shale, clay, slate — 4 in.	—	1.50
or slag; pumice) — 8 in.	—	2.00
12 in.	—	2.27
Concrete blocks, rectangular core[c]		
Sand and gravel aggregate		
2 core, 8 in. 36 lb.[k]	—	1.04
Same with filled cores[k]	—	1.93
Lightweight aggregate (expanded shale, clay, slate or slag, pumice):		
3 core, 6 in. 19 lb.[j]	—	1.65
Same with filled cores[k]	—	2.99
2 core, 8 in. 24 lb.[j]	—	2.18
Same with filled cores[l]	—	5.03
3 core, 12 in. 38 lb.[j]	—	2.48
Same with filled cores[k]	—	5.82
Stone, lime or sand	0.08	—

	Customary Unit Resistance[b] (R) Per Inch Thickness (1/k)	For Thickness Listed (1/C)
Gypsum, partition tile:		
3 × 12 × 30 in. solid	—	1.26
3 × 12 × 30 in. 4-cell	—	1.35
4 × 12 × 30 in 3-cell	—	1.67
PLASTERING MATERIALS		
Cement, plaster, sand aggregate	0.20	—
Sand aggregate — 0.375 in.	—	0.08
Sand aggregate — 0.75 in.	—	0.15
Gypsum plaster:		
Lightweight aggregate — 0.5 in.	—	0.32
Lightweight aggregate — 0.625 in.	—	0.39
Lightweight aggregate on metal lath — 0.75 in.	—	0.47
Perlite aggregate	0.67	—
Sand aggregate	0.18	—
Sand aggregate — 0.5 in.	—	0.09
Sand aggregate — 0.625 in.	—	0.11
Sand aggregate on metal lath — 0.75 in.	—	0.13
Vermiculite aggregate	0.59	—
ROOFING		
Asbestos-cement shingles	—	0.21
Asphalt roll roofing	—	0.15
Asphalt shingles	—	0.44
Built-up roofing — 0.375 in.	—	0.33
Slate — 0.5 in.	—	0.05
Wood shingles, plain and plastic-film faced	—	0.94
SIDING MATERIALS (On Flat Surface)		
Shingles		
Asbestos-cement	—	0.21
Wood, 16 in., 7.5 exposure	—	0.87
Wood, double, 16-in., 12-in. exposure	—	1.19
Wood, plus insul. backer board — 0.3125 in.	—	1.40
Siding		
Asbestos-cement, 0.25 in., lapped	—	0.21
Asphalt roll siding	—	0.15
Asphalt insulating siding (0.5 in. bed)	—	1.46
Hardboard siding — 0.4375 in.	0.67	—
Wood, drop, 1 × 8 in.	—	0.79
Wood, bevel, 0.5 × 8 in., lapped	—	0.81
Wood, bevel, 0.75 × 10 in., lapped	—	1.05
Wood, plywood, 0.375 in., lapped	—	0.59
Aluminum or steel[l], oversheathing		
Hollow-backed	—	0.61
Insulating-board backed nominal 0.375 in.	—	1.82
Insulating-board backed nominal 0.375 in., foil backed	—	2.96
Architectural glass	—	0.10
WOODS		
Maple, oak, and similar hardwoods	0.91	—
Fir, pine, and similar softwoods	1.25	—
Fir, pine, and similar softwoods — 0.75 in.	—	0.94
1.5 in.	—	1.89
2.5 in.	—	3.12
3.5 in.	—	4.35

Notes for Table A

[a]Representative values for dry materials were selected by ASHRAE TC4.4, Insulation and Moisture Barriers. They are intended as design (not specification) values for materials in normal use. For properties of a particular product, use the value supplied by the manufacturer or by unbiased tests.

[b]Resistance values are the reciprocals of C before rounding off C to two decimal places.

[c]Also see Insulating Materials, Board.

TABLE A (continued)

[d]Does not include paper backing and facing, if any. Where insulation forms a boundary (reflective or otherwise) of an air space, see Tables 1 and 2 for the insulating value of air space for the appropriate effective emittance and temperature conditions of the space.

[e]Conductivity varies with fiber diameter. Insulation is produced by different densities: therefore, there is a wide variation in thickness for the same R–value among manufacturers. No effort should be made to relate any specific R–value to any specific thickness. Commercial thicknesses general available range from 2 to 8.5.

[f]Insulating values of acoustical tile vary, depending on density of the board and on type, size and depth of perforations.

[g]The U.S. Department of Commerce. *Simplified Practice Recommendations for Thermal Conductance Factors for Preformed Above Deck Roof Insulation,* No. R 257-55, recognizes the specification of roof insulation on the basis of the C values shown. Roof insulation is made in thicknesses to meet these values.

[h]Face brick and common brick do not always have these specific densities. When density is different from that shown, there will be a change in thermal conductivity.

[i]Data on rectangular core concrete blocks differ from the above data on oval core blocks, due to core configuration, different mean temperatures, and possibly differences in unit weights. Weight data on the oval core blocks tested are not available.

[j]Weights of units approximately 7.625 in. high and 15.75 in. long. These weights are given as a means of describing the blocks tested, but conductive values are all for 1 ft^2 of area.

[k]Vermiculite, perlite, or mineral wool insulation. Where insulation is used, vapor barriers or other precautions must be considered to keep insulation dry.

[l]Values for metal siding applied over flat surfaces vary widely depending on amount of ventilation of air space beneath the siding; whether air space is reflective or nonreflective; and on thickness, type, and application of insulating backing-board used. Values given are averages for use as design guides, and were obtained from several guarded hotbox tests (ASTM C236) or calibrated hotbox (BSS 77) on hollow-backed types and types made using backing-boards of wood fiber, foamed plastic, and glass fiber. Departures of ± 50% or more from the values given may occur.

TABLE B

Factor C_D

Degree Days	CD
0	.85
1,000	.80
2,000	.75
3,000	.70
4,000	.65
5,000	.60
6,000	.62
7,000	.64
8,000	.65

TABLE C

Heating Value of Fuels*

Anthracite Coal	12,910 Btu/lb
Bituminous Coal	9,150 Btu/lb
#2 Fuel Oil	136,000–144,000 Btu/Gal.
#5 Fuel Oil	146,000–155,000 Btu/Gal.
#6 Fuel Oil	150,000–156,000 Btu/Gal.
Natural Gas	1,000 Btu/Cu. Ft.
LPG	91,690 Btu/Gal.
Steam	1,000 Btu/lb
Electricity	3,413 Btu/kwh

*Fuel heating values will vary. Specific values can be obtained from suppliers or building owners. If specific values are not available these values may be used as *estimates.*

TABLE D

LINEAR FOOT INFILTRATION SAVINGS FACTORS [a,b]

TYPE OF UNIT			Add weatherstripping only		Add storm windows/ doors only	Add weather-stripping & storm windows/doors	Add caulking
Component	Material	Condition	No existing storm windows/doors	Existing storm windows/doors			
double-hung window	wood	good	—	—	.07	—	—
		fair	.07	.05	.09	.14	—
		poor	.60	.42	.25	.67	—
	metal	good	—	—	.07	—	—
		fair–poor	.34	.24	.17	.41	—
sliding window	wood or metal	good	—	—	.07	—	—
		fair–poor	.60	.42	.25	.67	—
casement window	wood	good	—	—	.07	—	—
		fair–poor	.60	.42	.25	.67	—
	metal	good	—	—	.07	—	—
		fair—poor	.31	.22	.16	.38	—
awning window	wood	good	—	—	.07	—	—
		fair–poor	.60	.42	.25	.67	—
	metal	good	—	—	.07	—	—
		fair–poor	.31	.22	.16	.38	—
door	—	good	—	—	.14	—	—
		fair	.14	.10	.18	.28	—
		poor	1.20	.84	.50	1.34	—
crackage to be sealed by caulking		good	—	—	—	—	.017
		fair	—	—	—	—	.054
		poor	—	—	—	—	—

[a]Multiply these values by .75 if the house has no flues (neither furnace nor fireplace), and therefore no stack effect.

[b]Derived from values given in the *ASHRAE Handbook of Fundamentals*, The American Society of Heating, Refrigerating, and Air Conditioning Engineers, N.Y., 1974, Ch. 19; and G. T. Tamura, *Measurement of Air Leakage Characteristics of House Enclosures*, Paper No. 2339, Division of Building Research, National Research Council of Canada, Ottawa, Ontario, Canada.

APPENDIX E
Energy Audit Questionnaire for Multifamily Buildings

The best way to determine what specific energy conservation measures a multifamily building needs is to conduct a thorough "walk-through" inspection. This sample questionnaire is designed to aid in such a step-by-step inspection. (See Chapter 4 for further information about energy audits.)

The items included on the following pages are intended to pinpoint conservation needs. *Circled* answers to individual questions indicate that there may be energy-saving measures that can reduce costs and make the building more energy-efficient. Some of these energy-saving measures are discussed herein, while others are beyond the scope of this guide. For additional information on energy conservation measures, a particularly good reference source is the *Multifamily Housing Energy Conservation Workbook* (available from the New York State Energy Office, Agency Building 2, Rockefeller Plaza, Albany, New York 12223), from which this questionnaire was adapted. Other useful reference sources include:

Energy Conservation Guidelines for Saving Energy in Existing Buildings. Building Owners and Operators Manual (EMC1), Conservation Paper No. 20, Federal Energy Administration, June 1975.
Energy Conservation: Guidelines for Saving Energy in Existing Buildings. Building Owners and Operators Manual (EMC2), Conservation Paper No. 21.
Identifying Retrofit Projects for Federal Buildings. Federal Energy Administration, July 1976.

Note that items in this questionnaire preceded by an asterisk (*) are specifically designated by HUD Energy Standards for particular consideration.

An Audit Summary Sheet follows the questionnaire. This sheet gives the auditor a convenient means of summarizing his or her findings.

BUILDING OVERVIEW (Much of this information can be obtained from architectural and engineering drawings of the building.)

A. General Information
1. Number of floors in building: _____
2. Number of each type of dwelling unit (e.g., studio, one-bedroom): _____

B. Building Walls
3. Construction (check all items that apply):
_____ wood frame _____ brick veneer
_____ cavity wall _____ aluminum, vinyl siding
_____ concrete wall _____ wood siding
*4. Are the walls insulated?
_____ yes _____ (no)
If yes, type of insulation: _____
Thickness of insulation: _____
R- or U-value of insulation: _____

C. Roof of the Building
5. Construction (check all items that apply):
_____ flat _____ pitched
_____ wood frame _____ concrete
*6. Is the roof (or ceiling) insulated?
_____ yes _____ (no)
If yes, type of insulation: _____
Thickness of insulation: _____
R- or U-value of insulation: _____

D. Basement
7. Is any part of the building built on a concrete slab?
_____ (yes) _____ no
8. is the basement heated?
_____ yes _____ (no)
9. Is the floor over an unheated basement or concrete slab insulated?
_____ yes _____ (no)
(*Adding insulation may be cost-effective.*)
If yes, type of insulation: _____
Thickness of insulation: _____
R- or U value of insulation: _____

INDIVIDUAL APARTMENT (These questions should be answered by carefully inspecting a "typical" apartment in the building. Select one unit that is most representative of the conditions that exist in all of the building's apartments. The size of the apartment selected is not important, but choose a unit farthest from the heating plant. If no unit can truly be

considered typical, fill out a separate questionnaire for each type of apartment.)

A. General Information

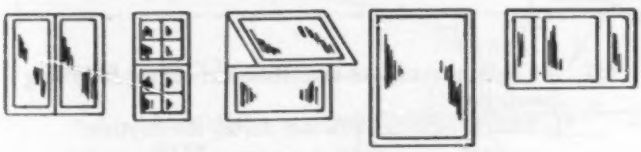
10. Apartment number: ____
11. Will it be necessary to fill out separate questionnaires for more than one apartment?
    ____ yes ____ no
12. Do the building's apartments have individual utility meters or checkmeters for electricity and/or gas?
    ____ yes ____(no)

B. Apartment Door (Answer these questions only if one or more aparment doors open to the outdoors.)

13. Is there a storm door? ____ yes ____(no)
14. If so, does the door fit tightly to the frame when closed (that is, no large gaps at top, bottom, or sides)?
    ____ yes ____(no)

C. Apartment Windows

Sliding | Double Hung | Hinged | Fixed | Casement



15. How many sliding windows are there in the apartment? ____
    Length: ____ Width: ____
16. How many double-hung windows are there?
    Length: ____ Width: ____
17. How many hinged windows are there? ____
    Length: ____ Width: ____
18. How many fixed windows are there? ____
    Length: ____ Width: ____
19. How many casement windows are there? ____
    Length: ____ Width: ____
*20. What is the condition of the weatherstripping? (Good weatherstripping completely seals the space between the window and frame.)
    ____ good ____(poor/none)
21. What is the condition of the putty? (Good putty adheres to the glass and is not dried or cracked.)
    ____ good ____(poor/none)
*22. What is the condition of the caulking?
    ____ good ____(poor/none)
*23. Do the windows fit snugly? (Tight windows should not rattle when shaken.)
    ____ tight ____(loose)

D. Apartment Heating and Cooling.

24. What type of heating units are there? individual or central system?
    ____ radiator ____ baseboard ____ hot air outlets ____ individual ____ central
*25. Do shut-off valves operate properly?
    ____ yes ____(no)
26. Do radiator vents operate properly?
    ____ yes ____(no)
27. Is there a thermostat in the apartment?
    ____ yes ____(no)
    If so, is it tenant-controlled?
    ____(yes) ____ no
    Is the thermostat located on an interior wall?
    ____ yes ____(no)
    *Is it a clock thermostat that can be set separately for day and night temperatures?
    ____ yes ____(no)
    What are the thermostat settings?
    Day ____ °F Night ____ °F

E. Apartment Hot Water

28. Do any faucets or showerheads leak or drip?
    ____(yes) ____ no
*29. Have flow restrictors been installed on bathroom faucets and showerheads?
    ____ yes ____(no)
*30. Have flow-restricting aerators been installed on sink faucets?
    ____ yes ____(no)

LOBBY AND CORRIDOR (If corridors vary in type and in condition, fill out separate questionnaires for each corridor type.)

A. Corridor and Stairwell Windows (See "Apartment Windows" on this page for illustrations of window types.)

31. How many sliding windows are there? ____
    Length: ____ Width: ____
32. How many double-hung windows are there? ____
    Length: ____ Width: ____
33. How many hinged windows are there? ____
    Length: ____ Width: ____
34. How many fixed windows are there? ____
    Length: ____ Width: ____
35. How many casement windows are there? ____
    Length: ____ Width: ____
*36. What is the condition of the weatherstripping?
    ____ good ____(poor/none)
37. What is the condition of the putty?
    ____ good ____(poor/none)
*38. What is the condition of the caulking?
    ____ good ____(poor/none)
*39. Are any windows cracked or broken?
    ____(yes) ____ no
*40. Do the windows fit tightly?
    ____ yes ____(no)

B. Interior Doors (other than apartment doors)

*41. Do doors close quickly and tightly?

_____ yes _____ (no)

*42. What is the condition of the weatherstripping?

_____ good _____ (poor/none)

C. Corridor and Stairwell Lighting

43. Count the number of fixtures, note the type of bulb and wattage, and fill out the following table.

	INCANDESCENT		FLUORESCENT	
NUMBER OF FIXTURES	BULBS/ FIXTURE	WATTS BULB	BULBS/ FIXTURE	WATTS/ BULB
Stairwell				
Corridor				

*44. If one is available, use a light meter to check the lighting level in the daytime. Fill out the chart below:

	CORRIDOR		STAIRWELL	
	AT WINDOWS	INTERIOR	AT WINDOWS	INTERIOR
Light On				
Lights Off				

*45. If a light meter is not available, answer the following questions:

*Are lights near windows shut off during the daytime?

_____ yes _____ (no)

Is the hall lighting bright or dim?

_____ (bright) _____ dim

*Are most lights controlled manually or automatically?

_____ (manually) _____ automatically

D. Corridor and Stairwell Heating

46. Are the corridors and stairwells heated?

_____ (yes) _____ no

(Temperature in such unoccupied areas of the building need not be kept as high as in dwelling units.)

*Are there control valves to limit the amount of heat provided?

_____ yes _____ (no)

(Thermostatic radiator valves are required if cost-effective.)

E. Lobby and Entrance Doors

47. Do doors close quickly and tightly?

_____ yes _____ (no)

*48. What is the condition of the weatherstripping?

_____ good _____ (poor/none)

F. Lobby and Entrance Lighting

*49. Count the number of fixtures, note the type of bulb and wattage, and fill out the following table:

	INCANDESCENT		FLUORESCENT	
NUMBER OF FIXTURES	BULBS/ FIXTURE	WATTS/ BULB	BULBS/ FIXTURE	WATTS/ BULB
Entrance				
Lobby				

*50. If one is available, use a light meter to check the lighting level in the daytime and nighttime. Fill out the chart below:

	AVERAGE LIGHT LEVEL NEAR WINDOWS	AVERAGE LIGHT LEVEL AWAY FROM WINDOWS
Daytime	Foot Candles	Foot Candles
Nighttime	" "	" "

*51. If a light meter is not available, answer the following questions:

*Is natural lighting sufficient during the daytime?

_____ (yes) _____ no

(Photocell controls can switch lights on and off according to need.)

*Are lights controlled manually or automatically?

_____ (manually) _____ auotmatically

G. Lobby Heating

52. Is the lobby heated?

_____ (yes) _____ no

(Lobby temperature can be kept lower than apartment temperatures.)

*53. Are there control valves to limit the amount of heat provided?

_____ yes _____ (no)

(Thermostatic radiator valves are required if cost-effective.)

HEATING PLANT (*Conduct this survey only on a day when the heating plant is operating.* Allow sufficient time to see the items operate through their full cycle.)

A. General Information

54. Heating plant:

Boiler number _____ Rating _____

_____ _____

_____ _____

Furnace number _____ Rating _____

_____ _____

55. Source of heating energy:
Hot water ____ Steam ____
Electric ____ Other ____

56. Boiler type:
Fire tube ____ Water tube ____
Electric ____ Other ____

57. Fuel used:
Oil ____ Number ____
Natural gas ____ Electric ____

58. Burner type:
Rotary cup ____ Pressure atomized ____
Air atomized ____ Steam atomized ____

B. Heating Plant Operation (Answer these quesions on a typical heating day with the boilers operating.)

59. Multiboiler installations: Do two or more boilers fire up and shut down at the same time?
____ (yes) ____ no

60. Does the boiler cycle go on and off frequently (about 5 minutes on and 5 minutes off)?
____ (yes) ____ no

61. Is a hot boiler kept on "standby"?
____ (yes) ____ no

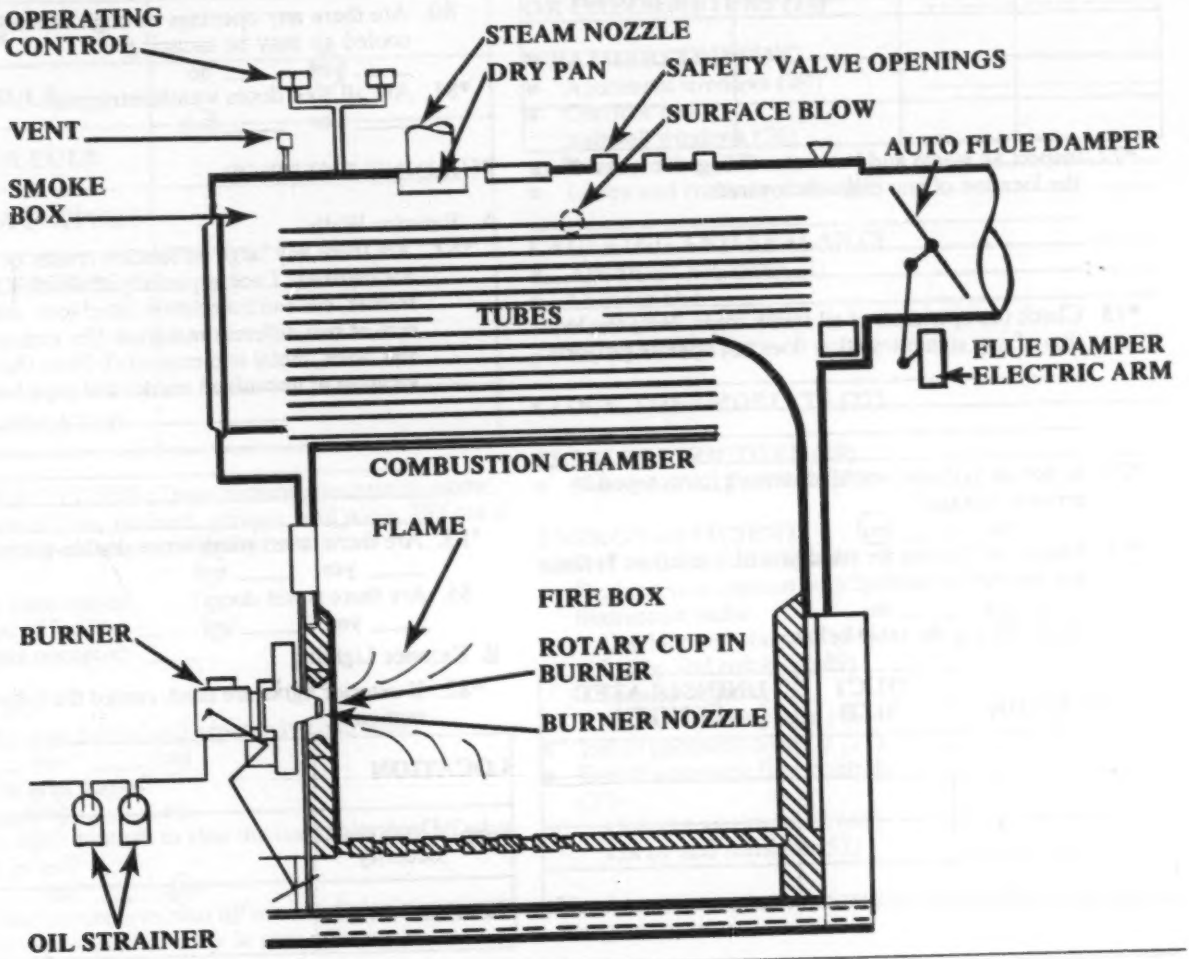
62. Is the boiler insulation cracked or missing?
____ (yes) ____ no

63. Is there an automatic flue damper in each boiler, and is it working properly?
____ yes ____ (no)

64. How is boiler operation controlled?
Pressure only (____)
Interior thermostat (____)
Interior/exterior thermostat (____)
*Variable temperature reset (____)

*65. What is the present combustion efficiency? Is it 80% or greater?
____ yes ____ (no)

66. Are there any fuel leaks on fuel-supply and return lines? ____ (yes) ____ no



67. Are the oil strainers clean?
_____ yes _____ (no)

68. Is the burner nozzle or rotary cup cleaned and inspected regularly?
_____ yes _____ (no)

69. Is the flame clean?
_____ yes _____ (no)

70. Are the walls and corners of the firebox blackened by soot?
_____ (yes) _____ no

C. Distribution and Piping System

*71. Inspect all steam and hot-water pipes and fittings for condition of insulation. Is there any insulation missing?
_____ (yes) _____ no
If yes, fill out the following table:

LOCATION	HOT WATER STEAM	PIPE DIAMETER	UNINSULATED LENGTH

*72. Inspect all steam and hot-water fittings for leaks. Note the location of any leaks discovered:
_____
_____
_____
_____

*73. Check the operation of all steam traps. Note the location of any steam trap that does not operate properly:
_____
_____
_____
_____

*74. In hot-air systems, are all ductwork joints taped to prevent leakage?
_____ yes _____ (no)

*75. Inspect all ducting for condition of insulation. Is there any insulation missing?
_____ (yes) _____ no
If yes, fill out the table below:

LOCATION	DUCT SIZE	UNINSULATED LENGTH

D. Domestic Hot Water

76. Is there a separate hot-water heater, or does the same boiler used to heat the building also heat the water?
_____ separate _____ (same)

*77. Is the hot-water heater located in a heated or unheated space?
_____ heated _____ (unheated)
(Insulating the hot-water heater is required if cost-effective.)

78. What is the condition of the hot-water storage tank insulation?
(_____) no insulation
(_____) some insulation, but not enough
(_____) insulated, but insulation is in need of repair
_____ adequately insulated

79. To what temperature is the water heated?
_____ ° F

ROOF

80. Are there any openings through which heated or cooled air may be escaping?
_____ (yes) _____ no

*81. Are all roof doors weatherstripped?
_____ yes _____ (no)

BUILDING EXTERIOR

A. Exterior Walls

*82. Are there any large infiltration cracks or gaps that are not caulked? Look especially at window and door frames, sill and foundation interfaces, and any interface of two different materials (for example, wood and brick, metal and masonry). Note the exact location of uncaulked cracks and gaps below:
_____
_____
_____
_____

*83. Are there storm windows or double-glazed windows?
_____ yes _____ (no)

84. Are there storm doors?
_____ yes _____ (no)

B. Exterior Lighting

*85. If exterior lights are used, record the following information:

LOCATION		
USE	Decoration Security	
TYPE OF BULB		

WATTS/BULB	
NO. OF BULBS/ FIXTURE	
HOURS OF USE/ DAY	
TYPE OF CONTROL Manual Photo Timer	

OUTDOOR PARKING AREA (owned and maintained by the property owner)

*86. Inspect the lighting in the outdoor parking area, and complete the chart below:

LOCATION	
TYPE OF BULB	
WATTS PER BULB	
BULBS PER FIXTURE	
TYPE OF CONTROL Manual Photo Timer	
HOURS OPERATED	

SPECIAL FACILITIES (These include community rooms, administration offices, kitchens, garages, and pools. Fill out a separate page for each special facility area.)

A. General Information
87. Type of facility: ____
88. Hours occupied: ____

B. Energy Use
89. Is the area heated and separately controlled?
____ yes ____ (no)
90. Is the area cooled?
____ (yes) ____ no
*91. Are there controls to shut the cooling system off when not in use?
____ yes ____ (no)
(Timer controls to shut off air-conditioning during unoccupied periods may be cost-effective.)

*92. What type of lighting is used?
____ (incandescent) ____ fluorescent

AUDIT SUMMARY SHEET*

	Number/Amount Needed
INSULATION	
■ Walls (4)	
■ Roof (6)	
■ Basement or concrete slab (9)	
■ Hot-water and steam pipes (71)	
■ Heating and cooling ducts (75)	
■ Hot-water heaters (77)	
■ Hot-water storage tank (78)	
■ Floors	
INDIVIDUAL UTILITY METERS OR CHECKMETERS (12)	
WEATHERSTRIPPING	
■ Apartment windows (20)	
■ Corridor and stairwell windows (36)	
■ Interior doors (42)	
■ Lobby and entrance doors (48)	
CAULKING AND SEALANTS	
■ Apartment windows (22)	
■ Corridor and stairwell windows (38)	
■ Exterior walls (82)	
CLOCK THERMOSTATS (27)	
FLOW RESTRICTORS (29)	
■ Flow-restricting aerators (30)	
ENERGY-EFFICIENT LIGHTING (in public spaces)	
■ Replace incandescent with fluorescent bulbs	
Corridor and stairwell (43)	
Lobby and entrance (49)	
Exterior lighting (85)	
Outdoor parking area (86)	
■ Install photocell controls (51)	
■ Install automatic time controls (51)	
Corridor and stairwell (45)	
Lobby and entrance (51)	

*Numbers in parentheses correspond to numbered items in the questionnaire.

Number/Amount Needed

THERMOSTATIC RADIATOR VALVES

- Corridor and stairwell (46) _____
- Lobby and entrance (53) _____
- Special facilities (89) _____

IMPROVED BURNERS, CONTROLS, CAPACITORS, AND OTHER ITEMS, FOR MECHANICAL SYSTEMS

- Boiler insulation (install/repair) (62) _____
- Automatic flue damper (install/replace) (63) _____
- Variable temperature reset (install) (64) _____
- Burner nozzle or rotary cup (clean/adjust/replace) (68) _____

STORM WINDOWS OR DOUBLE-GLAZED WINDOWS (83) _____

OTHER RECOMMENDED ENERGY MEASURES

_____

_____

_____

APPENDIX F
List of HUD Area Offices

HEADQUARTERS

Office of the Assistant Secretary for Community Planning and Development
Office of Urban Rehabilitation
Room 7168
451 7th Street, S.W.
Washington, D.C. 20410
(212-755-5685)

FIELD OFFICES

Region I

Boston, Mass., Area Office. Bulfinch Building, 15 New Chardon Street, Boston, Mass. 02114 (617-223-4111).

Hartford, Conn., Area Office. One Hartford Square West, Suite 204, Hartford, Conn. 06106 (203-244-3638).

Region II

Buffalo, N.Y., Area Office. Statler Building, Mezzanine, 107 Delaware Avenue, Buffalo, N.Y. 14202 (716-855-5755).

Newark, N.J., Area Office. Gateway 1 Building, Raymond Plaza, Newark, N.J. 07102 (201-645-3010).

New York, N.Y., Area Office. 26 Federal Plaza, New York, N.Y. 10278 (212-264-0644).

San Juan, P.R., Caribbean Area Office. Federico Degetau Federal Building, U.S. Courthouse, Room 428, Carlos E. Chardon Avenue, Hato Rey, P.R. 00918 (809-753-4201).

Region III

Pittsburgh, Pa., Area Office. Fort Pitt Commons, 445 Fort Pitt Boulevard, Pittsburgh, Pa. 15219 (412-644-2802).

Washington, D.C., Area Office. Universal North Building, 1875 Connecticut Avenue, N.W., Washington, D.C. 20009 (202-673-5837).

Baltimore, Md., Area Office. Equitable Building, 10 North Calvary Street, Baltimore, Md. 21202 (301-962-2121).

Philadelphia, Pa., Area Office. Curtis Building, 625 Walnut Street, Philadelphia, Pa. 19106 (215-597-2645).

Richmond, Va., Area Office. 701 East Franklin Street, Richmond, Va. 23219 (804-782-2721).

Region IV

Atlanta, Ga., Area Office. Richard B. Russell Federal Building, 75 Spring Street, S.W., Atlanta, Ga. 30303 (404-221-4577).

Birmingham, Ala., Area Office. Daniel Building, 15 South 20th Street, Birmingham, Ala. 35233 (205-245-1617).

Louisville, Ky., Area Office. 539 River City Mall, Louisville, Ky. 40202 (505-582-5251).

Jackson, Miss., Area Office. Federal Bldg., Suite 1016, 100 W. Capitol St., Jackson, Miss. 39201 (601-960-4702).

Greensboro, N.C., Area Office. 415 North Edgeworth Street, Greensboro, N.C. 27401 (919-378-5363).

Columbia, S.C., Area Office. Strom Thurmund Federal Bldg., 1835 U.S. Assembly Street, Columbia, S.C. 29201 (803-765-5592).

Knoxville, Tenn., Area Office. One Northshore Building, 1111 Northshore Drive, Knoxville, Tenn. 37919 (615-558-1384).

Jacksonville, Fla., Area Office. Peninsular Plaza, 661 Riverside Avenue, Jacksonville, Fla. 32204 (904-791-2626).

Region V

Detroit, Mich., Area Office. Patrick V. McNamara Federal Building, 477 Michigan Avenue, Detroit, Mich. 48226 (313-226-7900).

Chicago, Ill., Area Office. 1 North Dearborn Street, Chicago, Ill. 60602 (312-353-7660).

Indianapolis, Ind., Area Office. 151 North Delaware Street, Indianapolis, Ind. 46207 (317-269-6303).

Minneapolis–St. Paul, Minn., Area Office. Bridge Place Bldg., 220 South Second Street, Minneapolis, Minn. 55401 (612-349-3000).

Columbus, Ohio, Area Office. 200 North High Street, Columbus, Ohio 43215 (614-469-7345).

Milwaukee, Wis., Area Office. 744 North Fourth Street, Milwaukee, Wis. 53203 (414-291-1493).

Region VI

Dallas, Tex., Area Office. 1403 Slocum Street, Dallas, Tex. 75207 (214-729-8266).

San Antonio, Tex., Area Office. Washington Square, 800 Dolorosa, Post Office Box 9163, San Antonio, Tex. 78285 (512-229-6800).

Little Rock, Ark., Area Office. Savers Bldg., 300 W. Capitol Street, Suite 700, Little Rock, Ark. 72201 (501-378-5401).

New Orleans, La., Area Office. Plaza Tower, 1001 Howard Avenue, New Orleans, La. 70113 (504-589-2063).

Oklahoma City, Okla., Area Office. 200 N.W. 5th Street, Oklahoma City, Okla. 73102 (425-231-4891).

Region VII

Kansas City, Kans., Area Office. Professional Building, 1103 Grand Avenue, Kansas City, Mo. 64106 (816-374-6580).

Omaha, Nebr., Area Office. Univac Building, 7100 West Center Road, Omaha, Nebr. 68106 (402-221-9301).

St. Louis, Mo., Area Office. 210 North Tucker Boulevard, St. Louis, Mo. 63101 (314-425-4761).

Region IX

Honolulu, Hawaii, Area Office. 300 Ala Moana Boulevard, Roo 3318, Honolulu, Hawaii 96850 (808-546-2136).

San Francisco, Calif., Area Office. 1 Embarcadero Center, Suite 1600, San Francisco, Calif. 94111 (415-556-2238).

Los Angeles, Calif., Area Office. 2500 Wilshire Boulevard, Los Angeles, Calif. 90057 (203-688-5973).

Region X

Portland, Oreg., Area Office. 52 Southwest Avenue, Portland, Oreg. 97204 (503-221-2561).

Seattle, Wash., Area Office. 403 Arcade Plaza Building, 1321 Second Avenue, Seattle, Wash. 98101 (206-442-7456).

Anchorage, Alaska, Area Office. 334 West Fifth Avenue, Anchorage, Alaska 99501 (907-271-4170).

Region VIII

(Colorado, Montana, North Dakota, South Dakota, Utah, Wyoming).—Executive Towers, 1405 Curtis Street, Denver, Colo. 80202 (303-837-4513).

GLOSSARY

batt insulation Rock wool or glass fiber insulation sold in sections (batts) that are usually 15 or 23 inches wide and 4 or 8 feet long. Batts come with or without a vapor retarder backing.

blanket insulation Rock wool or glass fiber insulation sold in rolls, 15 or 23 inches wide. The installer cuts these rolls to the length desired.

BTU (British Thermal Unit) The amount of heat energy needed to raise the temperature of 1 pound of water by 1° F. The BTU content of a fuel indicates the heating volume of that type of fuel.

"C" thermal conductance See *U-value.*

capacitor A device on an electric circuit that balances current flow by temporarily storing electrical energy.

caulking A flexible material used to fill gaps and seal joints of a building to retard the flow of air, water, and heat.

cellulosic fiber insulation A loose-fill insulation made from wood or paper products and chemically treated to be fire resistant. Bags containing this insulation have a label indicating that the material meets federal specifications for fire resistance.

checkmetering The practice of an owner or manager of a building periodically reading, or "checking," tenants' electric meters to determine the amount of electricity being used.

clock thermostat A thermostat that can be preset to raise or lower indoor temperature automatically at desired times of the day or night.

conduction The flow of heat through one physical material to another or just out into the air. Heat flowing through the walls of a house is traveling by *conduction.*

convection Heating air to create a warm air current as a means of circulating heat throughout a space.

cooling hours The number of hours that the outdoor temperature is above a base temperature—usually 80° F—requiring indoor cooling.

cost-effectiveness The measure of the extent to which an energy improvement will "pay back," or recover, its original cost through savings in energy costs.

degree day, heating The measure of cold-weather intensity. Heating demand for an area is measured in terms of number of degree days in a year. For any one day, there are as many Degree Days as degrees difference in temperature between the mean temperature for the day and 65° F.

door sweep Vinyl or felt-backed metal strip applied to the bottom of a door to reduce air infiltration.

double-glazed window A window equipped with two layers of glass, usually: (1) a single-layer primary window and a storm sash; or (2) a two-layer, insulated glass window unit.

ductwork The channel that carries conditioned air to and from the source of supply.

electric ignition A device that ignites a heating system electrically. Unlike a pilot light, which burns constantly, this device is activated only when the system calls for heat.

electric resistance heat Heat produced by the flow of electricity through high-resistance wire, tape, or film.

energy audit An on-site inspection or survey of a building to establish how energy is used and to identify ways to improve

	efficiency. The audit covers building design, maintenance practices, mechanical equipment operation, and other factors.
energy auditor	An individual who is qualified and/or certified to perform energy audits.
energy review	The part of a rehabilitation inspection that considers the need for energy-saving modifications and determines whether such modifications would be cost-effective. It is similar to an *energy audit.*
energy standard	A design requirement or criterion for making cost-effective improvements to buildings to insure more efficient utilization of energy.
estimated first-year savings	An estimated dollar amount of savings expected to result in the first year after the installation of an energy conservation improvement.
fiberglass insulation	Insulation made out of glass fiber and sold in batts, blankets, or as loose-fill.
flow restrictor	A control device, or valve, placed in faucets and showerheads to restrict the flow of water to a specified maximum number of gallons per minute.
gasket	Either (1) an elastic packing used around pipe joints to prevent the escape of fluids and gases, or (2) a flexible, compressible material installed around the moving parts of doors and windows and between different structural materials to prevent air infiltration.
heat pump	A heating/cooling system that operates like an air conditioner in summer and a heater in winter. Electrically operated, it is more efficient than electric resistance heat in most climates.
high-efficiency lighting	Low-cost, low-energy lighting, achieved by such actions as replacing incandescent lamps with fluorescent lamps; using energy-efficient fluorescent bulbs; installing time controls on lights; designing lighting for specific activities (task lighting); and making judicious use of daylight.
infiltration	The leakage of air through cracks and openings in a building.
loose-fill insulation	Insulation that is either poured or blown into floors or walls. Poured-in loose-fill is made from cellulosic fiber, rock wool, fiberglass, granulated cork, vermiculite, slag, and other fibers. Blown-in loose-fill is made from cellulosic fiber, rock wool, or fiberglass.
mineral wool	See *rock wool insulation.*
net present value	The total anticipated savings over the life of an energy modification minus the cost of installation, maintenance, and financing (including initial purchase cost).
outdoor reset	A thermostatic device that automatically raises or lowers the boiler water-supply temperature inversely as outdoor temperature changes.
payback period	The amount of time necessary to recover the installation cost of an energy conservation measure, such as insulation, through savings in energy costs.
perm	The unit of measurement of the water-vapor permeability of a material. A value of one perm is equal to one grain of water vapor per square foot per hour per inch of mercury.
permeance	The rate of moisture transmission through materials. A low permeance means that moisture is transmitted through a material at a slow rate.
R-value (thermal resistance	The measure of a material's insulating ability or resistance to heat flow. The higher the R-value of a material, the higher its insulating value.
radiation	The emission of heat in concentric waves.
rehabilitation	Upgrading a damaged or deteriorated building to its formerly sound condition.
Residential Conservation Service	A program authorized by the National Energy Conservation Policy Act in 1978 and administered by the Depart-

	ment of Energy. The program enables homeowners and renters to obtain audits, information, and assistance from their local utility companies on financing and installing energy-saving improvements.
retrofit	To add energy-saving materials or devices or to otherwise alter a building for increasing energy efficiency; weatherize.
rigid board insulation	Insulation made of fiberglass, polystyrene, polyurethane, or other materials sold in the form of lightweight panels or boards.
rock wool insulation	Insulation made from molten rock or slag fibers and sold in the form of batts, blankets, or loose-fill. Rock wool is also commonly referred to as mineral wool.
rolled vinyl weatherstripping (also called flexible vinyl or vinyl bulb)	Durable vinyl weatherstripping made with a metal backing for doors and without a backing for windows.
sealant	A flexible material placed in building joints to block the flow of air, heat, or moisture. *Caulking* is a *sealant.*
sheathing	The covering (usually wood boards, plywood, or wallboard) placed over a building's frame to provide a base for the application of roofing or siding.
spring metal weatherstripping (also called spring bronze)	The most durable type of weatherstripping, applied to both doors and windows.
storm door	An extra door installed outside of an exterior primary or ordinary door to reduce heat loss and air infiltration.
storm window	An extra window, usually installed outside the primary window, designed to reduce heat loss and air infiltration.
therm	A quantity of heat equal to 100,000 BTUs.
thermal break	A layer of insulating material put between the inner and outer frames of a metal-framed window or door to prevent heat flow through the frame.
thermal door	A tight-sealing door made with a core of insulating material to provide increased resistance to heat flow.
thermostatic radiator valve	A control valve installed on a radiator to automatically adjust heat output.
triple-track (or combination) storm window	A storm window unit with screens, principally designed for use with double-hung or sliding windows. It is permanently installed and can be easily opened for ventilation.
U-value	The reciprocal of R-value. The rate of heat transmittance through a material, or assemblage, of 1 square foot in area, measured in BTUs per hour, and based on an indoor–outdoor temperature difference of 1° F (BTU/hr ft^2 F). Cf. *R-value.*
vapor barrier	See *vapor retarder.*
vapor retarder	A specially treated paper or thin plastic or foil sheet that resists moisture penetration. Its primary purpose is to reduce condensation of water vapor within the building.
weatherization	The process of retrofitting a house or building to improve its energy efficiency. See also *retrofit.*
weatherstripping	Flexible metal, rubber, felt, vinyl, or foam materials installed around the moving parts of windows and doors to prevent air leaks.
wood-frame construction	Construction principally using wood studs, joists, and beams to form the frame of a building.
zoned heating	A method of balancing the heat supply in single-family or multifamily buildings by having separate thermostats regulate the heat in different rooms, apartments, or other areas of a building.

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